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The American Midland Naturalist

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Vol. XI. SEPTEMBER, 1928. No. 5.

THE SHELLROCK STAGE OF THE DEVONIAN OF IOWA[1]

C. H. BELANSKI

III. STRATIGRAPHIC AND FAUNAL RELATIONSHIPS.

Previous work upon the Shellrock strata, particularly that of Calvin, has consisted largely or correlations based upon the presence of spheroidal stromatoporoids. Reefs and beds of such stromatoporoids occur at Waterloo, Charles City, Marble Rock, Nora Springs, Mason City, and at many other localities.

Unfortunately, very few of the stromatoporoids composing these reefs are known sufficiently well to permit even generic identification. Very few of them exhibit distinct external form, or can be recognized from broken sections. Clearly, then, these fossils are unsuitable for indices and it is not to be wondered that correlations made upon their evidence have proved to be erroneous.

An example of such an error is to be found in the correlation of the beds of spheroidal stromatoporoids at Mason City. Without actually tracing these beds Calvin[2] nevertheless correlates them with apparently similar beds near river level at Nora Springs, which in turn he correlates with still other stromatoporoid beds at Marble Rock. Now

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[1]Parts I and II of this paper appeared in this journal, vol. 10, pp. 317-370, 1927.

[2]Ia. Geol. Surv. vol. 7, pp. 145-146, 1897.

by careful tracing[3], Calvin's stromatoporoid beds at Mason City are found to be the equivalent of the First Actinostroma zone, which lies some twenty-five feet above the stromatoporoid bed (Pachyphyllum zonule) along the river at Nora Springs. On the other hand, similar tracing shows that the Nora Springs reef is represented at Mason City by dolomite and shales occupying a horizon some fifteen feet below the stromatoporoid beds of Calvin. Again, tracing this Nora Springs reef southward it is seen to feather out and disappear far short of the points where the spherical stromatoporoid beds of the Marble Rock section appear. The reef so conspicuously shown in the Marble Rock sections lies from ten to twenty-five feet below the horizon of the Pachyphyllum zonule.

Although the general shape and character of the stromatoporoids of the Marble Rock reef, and to a certain extent the lithology of the beds, are similar to that of the Pachyphyllum zonule, they are accompanied by a brachiopod-molluscan fauna that is widely different from that of the Pachyphyllum beds or from any faunule to be found in the Shellrock. The Marble Rock reef is equivalent to similar stromatoporoid beds shown at Floyd but the stromatoporoid reef at Charles City lies well below the horizon of the Floyd-Marble Rock reef and carries a slightly different brachiopod-molluscan fauna. Although these two sets of reefs occupy a horizon that would indicate Cedar Valley age, their correlation with similar stromatoporoid reefs at Waterloo, Garrison and Iowa City must be regarded as doubtful until careful tracing shows their exact relationships.

Having for the present abandoned the stromatoporoids as means of correlating these two sets of strata, we must

[3]Although sections are not given in the present paper, the strata of the Shellrock have been traced in numerous exposures along Lime Creek from Rockford to Fertile, and the results obtained have been checked by sections of the strata along the Shellrock which are given in the present paper.

turn to other fossils for criteria to determine their relationships. Although the greater part of the Cedar Valley fauna of Iowa is unstudied, certain diagnostic forms are described in papers by Hall,[4] Thomas,[5] and other authors. Of these fossils there may be mentioned *"Acervularia davidsoni"* M.-E. & H., *"Acervularia profunda"* Hall, *Codaster subtruncatus* (Hall), *Nucleocrinus obovatus* (Barris), *Melocrinus nodosus* Hall, *Megistocrinus farnsworthi* White, *M. latus* Hall, *M. pernodosus* Thomas, *Spirifer iowensis* Owen,[6] *S. asper* Hall, *Gypidula comis* (Owen) and *Pentamerella dubia* (Hall).

Were the Shellrock beds of Cedar Valley age we would expect to find some, if not all, of these species in their fauna. However, not one of them is known to occur in the Shellrock, the diagnostic fossils of which are *Trigonotreta shellrockensis* n. sp. *Camarophoria paupera* Belanski, *Lepidocentrus ? thomasi* n. sp. *Pachyphyllum websteri* n. sp. *Hexacrinus springeri* Thomas, *Strobilocystites schucherti* Thomas, *Cylindrophyllum floydensis* n. sp., *Phillipsastrea minutissima* (Webster), and *Stropheodonta cicatricosa* n. sp. Of these species not one occurs in known Cedar Valley faunas. Of the nearly three hundred species known from the Shellrock less than ten percent are related to or identical with Cedar Valley species. Clearly then the Shellrock fauna points to separate age.

Turning now to stratigraphy, we find that the Shellrock beds differ widely in lithologic character from the Cedar Valley of the same area, and from the Cedar Valley of the central and southern parts of the state. Moreover, the succession of beds is such that they can not be correlated with the true Cedar Valley strata.

Equally important is the fact that wherever their contact is exposed, the Shellrock strata are separated from

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[4]Geol. of Iowa, vol. 1, pt. 2, 1858.

[5]Ia. Geol. Surv., vol. 29, 1924.

[6]Recent study of this brachiopod indicates strongly that it belongs to the genus *Platyrachella*.

those of the Cedar Valley by a sharp, persistent unconformity. In the erosion interval thus indicated from two to ten feet of very durable limestones were removed. Not only were the Shellrock strata deposited in a basin eroded in the Cedar Valley, but they also overlap upon the Cedar Valley in their southern and eastern phases. Thus at Nora Springs the Aulopora zone, some fifteen feet thick, forms the basal zone of the Shellrock. At Rockford the thickness of this zone decreases to seven feet and at Marble Rock it is absent. From Marble Rock southward the Trigonotreta zone forms the base of the stage, and like the Aulopora zone, thins to the southeastward, first by the feathering out of the basal shaly zonule, and at Greene, by the thinning of the Stropheodonta zonule. As a result the thickness of the Mason City substage decreases from twenty-two feet at Nora Springs to less than four feet at Greene.

Throughout the Shellrock there are numerous unconformities showing that the advance of the sea was irregular. None of these unconformities, however, approach the significance of the one at the base of the stage as in many cases beds separated by unconformities in one phase may be merged together as a unit in another phase. Furthermore, the faunas above and below the unconformities show close relationships. The most pronounced intraformational unconformity is that at the base of the Nora Substage, but above it appear abundant fossils found in the basal zones of the stage. These numerous breaks in sedimentation must have been caused by slight oscillations in the level; they indicate the closeness of the eastern margin of the basin, which is also indicated by the rapid thinning of the several members to the south and east.

So much, then, for the separation of the Shellrock strata from the underlying Cedar Valley. It remains to determine their relationship to the overlying beds.

Resting upon the Shellrock is the Juniper Hill formation, consisting of heavy-bedded fine mud-shales carrying a fauna which contains not a single Shellrock species and

but few Shellrock genera. Wherever observed, the contact between the two formations is sharply unconformable, made clearer by the sharp lithologic break. There is no evidence, however, that the unconformity has resulted from the removal of any great thickness of Shellrock strata, even though evidence of an erosional contact is clear.

Overlying the Juniper Hill formation are the shales, shaly limestones, and dolomites of the Hackberry stage. While lithologically distinct from the Shellrock strata, and separated from them by some fifty feet of shale bearing a wholly distinct fauna, the Hackberry shows considerable faunal similarity to the Shellrock. Although but few species are common to both stages, there are many genera whose species are closely related. In *Cranaena*, *Trigonotreta*, *Platyrachella*, *Camarophoria*, *Devonocidaris*, *Nortonechinus*, *Platyschisma*, *Phillipsastrea*, *Alveolities* and *Tabulophyllum* are many Shellrock species which apparently are ancestral to Hackberry forms.

It might be inferred from the previous statements that the Shellrock fauna is a mixture of Cedar Valley and Hackberry types, however, this is not the case. It is true that about ten percent of the Shellrock fauna is most closely related to Cedar Valley species, and about twenty per cent find their closest relatives in the Hackberry fauna; but the remaining seventy per cent, though containing less than half the specimens found, comprise the diagnostic Shellrock fauna, and the proportion probably will be increased when the stromatoporoids are described. Some of the genera containing typical Shellrock species are *Eatonia*, *Lepidocentrus* ?, *Pachyphyllum*, *Hexacrinus*, *Craspedophyllum*, *Coenites*, and *Sieberella*.

A study of the species, thus far, indicates that the Shellrock fauna has an origin distinct from either the Cedar Valley or the Hackberry faunas. From the relationships now known it would seem that the ancestral fauna of the Shellrock must be sought in the Devonian of the Mackenzie basin, or more remotely, in that of the German Eifel.

IV.—SUMMARY.

I. The Shellrock strata, as here defined, form a distinct stage in the upper Devonian of Iowa which is:

   A. Composed of beds different in character from those of the Cedar Valley stage, bearing distinct faunas, and separated from the Cedar Valley by a marked and persistent unconformity, representing the erosion of two to ten feet of very durable lithographic limestone.

   B. Composed of beds lithographically and faunally distinct from those of the overlying Juniper Hill formation, which everywhere is unconformable upon the Shellrock.

   C. United throughout its several members by a faunal similarity, despite the numerous unconformities within the stage, none of which approach in significance those which define it.

II. The Shellrock strata were deposited in a basin upon eroded Cedar Valley rocks, in a sea which was advancing southward, as is shown by the progressive overlap upon the Cedar Valley beds.

III. The Shellrock sea advanced irregularly, with many oscillations and retreats, as is shown by the numerous unconformities within the stage, some of which, however, may represent subaqueous erosion.

DESCRIPTIONS OF SOME TYPICAL FOSSILS OF THE SHELLROCK STAGE[1]

C. H. BELANSKI

I.—INTRODUCTION.

In my account of the stratigraphy of the Shellrock stage, completed in the present number of this magazine, reference has been made to the fact that most of its typical fossils belong to species that have not heretofore been described. The purpose of this paper is to provide descriptions and illustrations of such forms as are mentioned.

It will be noted that each description is accompanied by a paragraph giving the location of the types. The abbreviations used in these paragraphs are as follows:

C. H. B.—Collection of C. H. Belanski
U. C. M.—University of Cincinnati Museum
U. S. N. M.—United States National Museum
W. M.—Walker Museum, the University of Chicago.

II.—DESCRIPTIONS OF FOSSILS.

Phylum COELENTERATA

Class ANTHOZOA

PACHYPHYLLUM WEBSTERI N. SP.

Plate XII, Fig. 3.

Description.—Corallum formed of confluent corallites that originate by septal and marginal-calycinal gemmation, and which diverge from a common base to form irregular convex or hemispherical masses reaching 40 cm. in greatest diameter and 15 cm. in thickness, the area of attachment commonly being confined to the original corallite.

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[1]Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 6.

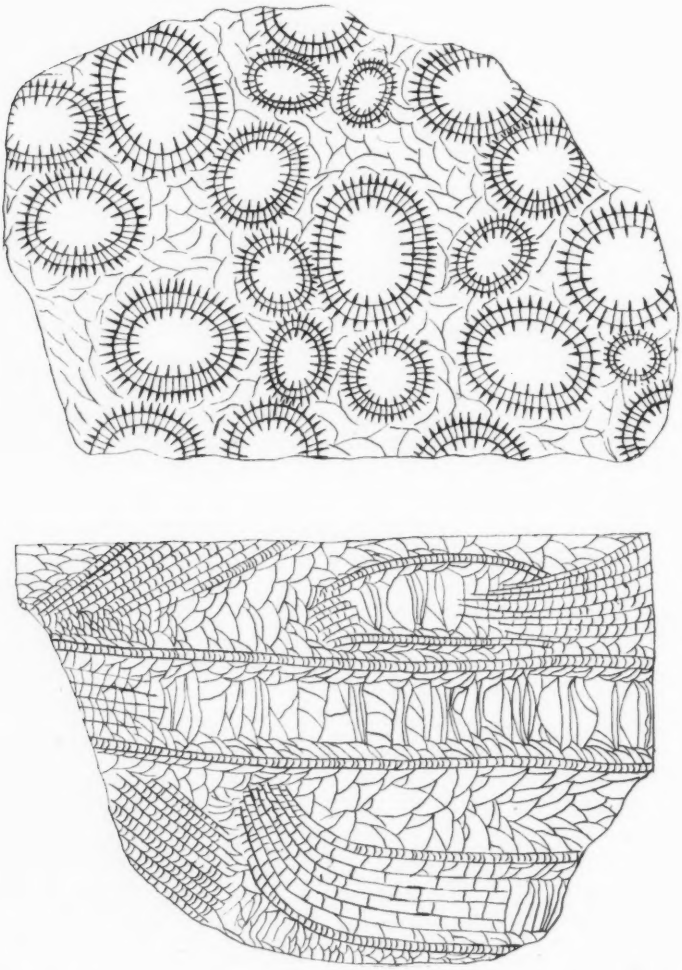

Fig. 1.—A vertical and a transverse section of a corallum of *Pachyphyllum websteri* showing the double mural ring, non-confluent septa, tabulae of the intra-mural area etc. x3.

Corallites 6 to 14 mm. in diameter, without well defined margins. The central portion of each consists of a deeply depressed pit (the intramural area), surrounded by an exsert ring (the mural area), which in turn is surrounded by a depressed area (the extramural area) which extends to the margins of the corallite. The diameter of the exsert rings varies from 5 to 11 mm. and their elevation above the extramural area from 2 to 11 mm.; the bottom of the intramural pit is about on the same level as the extramural area. Mural walls thick and nearly vertical; their upper rims sharply rounded.

Bottom of the intramural pit flat or gently concave, bearing a small, smooth transverse diaphragm. Septa 32 to 48 in number, apparently smooth. On the inner mural wall the primary septa extend to the margins of the diaphragm, the secondaries being very fine and reach but a short distance down the wall. Both sets of septa are of equal strength at the top of the exsert mural ring and extend downward and outward over the extramural area where they meet those of adjoining corallites and fuse with them.

In a vertical section the mural wall is seen to be double, being composed of very small, vertically arranged dissepiments the inner and outer walls of which are heavier than those above and below. The intramural area is divided into a central tabulate zone which is about two-thirds the width of the area and which is surrounded by a zone of dissepiments that extend to the inner mural wall. Tabulæ flat or gently convex, very irregularly spaced; in some places 2 mm. apart, in others crowded, 2 to 4 in the space of a millimeter. Dissepiments small, inclined upward and outward, commonly enroaching upon the tabulate zone. The extramural area composed of large irregular dissepiments which are confluent with adjoining corallites.

In a transverse section the mural area of each corallite appears as a large double-walled ring which bears a short cycle of primary and secondary septa. Both sets of septa project about 1 mm. beyond the outer wall of the ring

where their ends are abruptly pointed. On the inner side of the area only the primaries are shown as sharp points which extend less than 1 mm. into the intramural area. The secondary septa extend only to the second or inner ring of the area. The septa on the outer wall of the area are never confluent with those of adjoining corallites even when the rings are so closely crowded as to be almost in contact. The extramural area shows only large dissepiments.

Remarks.—From the fact that the septa of adjoining corallites are not confluent internally, this species appears to be the only representative of this genus which is known in Iowa. The various corals from the overlying Hackberry beds, which have been described as species of *Pachyphyllum*, all show confluent septa internally, a feature which places them in the genus *Phillipsastrea*. The only other member of *Pachyphyllum* known to occur in America is *P. devoniense* M-E. & H. which occurs in the Devonian of the Peace River district of Canada. From that species *P. websteri* differs in having primary septa which do not reach to the center, more irregular tabulae, and more closely spaced mural rings. Specific name in honor of the late Clement L. Webster.

Occurrence.—Confined to the Aulopora zone, being most common in the Pachyphyllum zonule at Nora Springs. Specimens are never abundant and have a very limited geographic range.

Holotype.—No. 2176; *Paratypes.*—Nos. 529, 626, 646, C.H. B., No. 71030, U.S.N.M., Nos. 1470 and 1478, U.C.M.

PRISMATOPHYLLUM OWENI N. SP.

Plate XII, Fig. 2.

Description.—Corallum composed of polygonal, intimately united corallites which increase by interstitial gemmation, diverging from a common base to form large irregular convex masses up to 20 cm. in diameter and often of equal or greater thickness. Marginally, or rarely centrally, the corallites tend to grow independently and in such cases

they are covered by a heavy continuous, transverely wrinkled epitheca.

Corallites 5 to 14 mm. in diameter; usually polygonal with their margins sharply angular and rather strongly elevated; although independent corallites are subcircular in section with the outer margins gently rounded outward and downward. Calyces nearly as deep as wide, the walls at first sloping gently toward the center, near which they descend abruptly to form a deep flat-bottomed pit whose diameter is one-third to one-half that of the corallite and whose depth, as a rule, is nearly twice the width. The bottom of the pit bears a small transverse diaphragm. Septa 34 to 40 in number, strong and prominent, their crests marked by rounded denticulations. The primary septa reach the margins of the central diaphragm, the secondaries generally fail to reach the margins of the depressed pit.

Vertical sections show each corallite to be bounded by a thin but definite wall with a tabulate area occupying more than one-third of the central portion. Tabulae thin; 1 to 3 in the space of 1 mm.; their central third is flat or gently convex, their outer area gently deflected; many are confined to the central, more flattened portion. Surrounding the tabulæ is a broad region of flattened dissepiments directed upward and outward. In a transverse section the primary septa reach about half way to the center, and the secondary septa are marginal.

Remarks.—The most closely related coral from the Iowa Devonian is the one described by Hall[2] as *Acervularia davidsoni* ? M-E. & H. from the Cedar Valley beds of Johnson and Black Hawk counties, but which is quite unlike authentic specimens of *A. davidsoni* from Ferques, France. However the present species differs widely from the Cedar Valley form in the deeply depressed central pit. The specific name is in honor of David Dale Owen.

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[2]Geol. of Iowa, vol. 1, pt. 2, pp. 476-477, pl. 1, figs. 8a-b, 1858.

Occurrence.—Common in the Prismatophyllum zonule at Rudd and in the Macgeea zonule north of Nora Springs. It is also more or less common in the Strobilocystites zonule at Rockford. Types from the Prismatophyllum zonule.

Holotype.—No. 471; *Paratypes.*—Nos. 134, 1522, C.H.B., No. 71041, U.S.N.M., and No. 1474, U.C.M.

CYLINDROPHYLLUM FLOYDENSE N. SP.

Plate XII, Fig. 1.

Description.—Corallum composed of small cylindrical highly flexuous corallites, which increase rapidly by lateral gemmation and diverge from a common base to form flattened or irregularly convex masses reaching 40 cm. in diameter from 6 to 10 mm., generally closely crowded and more or less fused in their lower portions, their upper portions being separated by intervals ranging from one-third to more than twice their diameter. In most cases each corallite bears but one bud which expands rapidly and soon gives forth a similar bud, the vertical intervals between them ranging from 3 to 30 mm. or more. Some corallites bear two, or rarely three, buds before being overgrown by the lateral expansion of later corallites, whose rapid increase generally leads to the extinction of the parent ones. Epitheca strong and generally continuous, marked by numerous transverse constrictions and annulations of growth, the latter generally bearing small nodose expansions which, depending on proximity, may or may not fuse with similar expansions from adjoining corallites. When well preserved the epitheca is further marked by faint, rounded costal grooves corresponding to the septa beneath.

Calyx varies in depth from one-third to three-fourths of the diameter; bottom rounded, bearing a small, central depressed pit occupied by a narrow transverse diaphragm. Walls of the calyx curve steeply upward, their margins being slightly reflected outward. Septa strong, straight, neither denticulate nor crenulate, 30 to 34 in number. Sec-

ondary septa thinner than the primaries, extending less than one-half the distance to the center. The primary septa reach the margins of the central diaphragm.

A vertical section shows a central tabulate zone occupying more than one-third the diameter, and an outer dissepimental zone. The tabulæ are strong, moderately convex, from 2 to 5 in the space of 1 mm. The dissepiments bordering the tabulate area are large and nearly horizontal; those bordering the outer wall are about one-half their size and are directed upward and outward. Transverse sections show the outer ends of the septa to be thickened and fused to form a thin outer wall.

Occurrence.—Very common in both members of the Lepidocentrus zone at Nora Springs, ranging southward to Greene and Northward to the Bjorgason phase.

Holotype.—No. 2001; *Allotype.*—No. 1361; *Paratypes.*—Nos. 364, 753, 2003, C.H.B., No. 71029, U.S.N.M., and No. 1477, U.C.M.

Phylum ECHINODERMATA

Class Crinoidea

BACTROCRINUS WESTONI N. SP.

Plate XIII, Figs. 35-37.

Description.—Specimens of medium size, with elongate calyces and slender isotomous arms. All plates of the calyx smooth, very slightly depressed along the sutures. The IBB and BB united by close suture to form a gently tapering cone, the proximal diameter of which is but slightly greater than the width of the stem. IBB 5, pentagonal, subequal, slightly higher than wide. BB 5, their height from 3 to 4 times their greatest width, gradually widening upward their upper portions gently outcurved; 3 of them hexagonal, the r. post. and r. ant. truncated above and heptagonal in outline. RA missing in all specimens noted although its size and shape can be told from the sutures of adjacent plates; apparently small, quadrangular, resting directly

upon the truncated r. post. B and supporting a pentagonal tube plate; a portion of its right side fitting into a recess in the lower left side of r. post. radial. Anal X hexagonal, in line with, and slightly smaller than the RR, resting on the adjacent shoulders of the two posterior BB, and partially supporting two tube plates; its right side separated from r. post. R by RA and t.p.

RR 5, about as wide as high; the anterior and l. ant. RR. pentagonal, the r. and l. post. RR hexagonal, the r. ant. R quadrangular and resting directly upon the truncated r. ant. B; in contact with each other for nearly their entire length, the facet slightly narrower than the greatest width of the RR, the surface of the plate below the facet somewhat rounded outward. IBr very slightly cuneate, nearly as high as wide, the full complement shown only on the r. ant. ray of the paratype where they are 5 in number, the upper being a IAx. Several series of brachials beyond the IBr are shown on the allotype; they are moderately cuneate, generally higher than wide, from 8 to 10 in the IIBr, IIIBr, and IVBr series. Each brachial above the IBr bears a delicate ramule near the top of its wider side. Ventral sac unknown. Stem round or obtusely pentagonal, composed of uniform ossicles which bear cirri along the lower portion of the stem.

Remarks.—The above description is based upon several incomplete specimens, which together give a fairly good idea of the appearance of the species when complete. The holotype consists of a united set of IBB and BB, with the proximal stem ossicle. A paratype shows the RR, most of the IBr, and a few of the IIBr and part of the base of the anal system. Still another specimen, the allotype, shows a group of slender ramulate arms. A paratype, preserving but one side of the calyx, shows 2 elongate BB, 3 RR and a few of the IBr. In addition, several hundred separate plates serve to supplement observations based upon the above specimens.

The genus *Bactrocrinus* has hitherto been known only

from the Lower and Middle Devonian of Germany; its occurrence in the Iowa Devonian is interesting and serves to further emphasize the relationship between the faunas of the German and the Iowa Devonian. With it are associated *Nassoviocrinus* and *Trigonotreta* both of which are found with *Bactrocrinus* in the German Devonian. No other crinoid from the Iowa Devonian approaches this species closely enough to warrant comparison. Specific name in honor of Dr. B. F. Weston of Mason City, an enthusiastic collector of local fossils.

Occurrence.—Confined to the Trigonotreta zone, being particularly common in the Bactrocrinus zonule[3] at Rockford and in the Nassoviocrinus zonule at Nora Springs. At both points its scattered stems and plates occur by the thousand, and compose the greater portion of these beds.

Holotype.—No. 1675; *Allotype.*—No. 1980; *Paratypes.*—Nos. 1982 and 1861, C.H.B.

NASSOVIOCRINUS GOLDRINGAE N. SP.

Plate XIII, Figs. 38-39.

Description.—Specimens of medium size, with elongate crown and the IBr arrangement characteristic of the genus. Calyx turbinate, rather low, about as wide as high; IBr filling the distal faces of the RR. Surface of the plates smooth. Rounded pits mark the distal corners of the BB and broad depressions set off the sutures between them. Similar but smaller pits locate the distal angles of the IBB and of some of the RR. Arms universal, dichotomous. Stem pentalobate, tapering very gradually, every fifth or sixth columnal slightly wider than the others and generally bearing cirri, especially on the lower portions of the stem. Dimensions of the holotype: width at top of BB 5.8 mm.; height to top of BB 4.9 mm.; height to top of IAx 18.7 mm.; total length to top of IIBr 7 28.3 mm.

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[3]The Bactrocrinus zonule replaces the Poteriocrinus zonule of parts I and II and the term Nassoviocrinus zonule replaces the Decadocrinus zonule as there used, the two crinoids here described being the forms previously referred to *Poteriocrinus* and *Decadocrinus*.

IBB five, pentagonal, about twice as wide as high, united to form a low ring whose diameter is considerably greater than the proximal stem ossicle. BB five, nearly as wide as high, the two posterior ones heptagonal, the other three hexagonal. Anal side (as seen in paratype No. 1983) of poteriocrinid character, with RA. The truncate l. post. B supports the anal X, and the r. post. B supports a large hexagonal radial. RA pentagonal, resting point downward on the adjacent shoulders of the posterior BB, truncated above and supporting a large tube plate. Anal X pentagonal, slightly smaller than the RA, its distal angle apparently rounded and turned inward, situated between RA and l. post. R, its right shoulder in contact with tube plate. All plates of the calyx firmly united by close suture.

RR five, wider than high, pentagonal except for the r. post., the entire upper face occupied by the facet. Brachial series robust, deeply rounded; IBr 7 to 8 in number, more or less cuneate, the lower ones especially so. IIBr similar to IBr, but smaller; unknown beyond IIBr 7. Pinnules short and delicate, borne alternately near the top of the wider end of each brachial. Ventral sac unknown.

Remarks.—The present species apparently is closely related to the species from the German Lower Devonian figured by Jaekel as *N. pachydactylus* (Sandberger)[4] which *N. goldringae* resembles in its pentagonal stem, reduced anal system, number of primibrachs, and in the depressed areas at the corners of the plate. In *N. goldringae*, however, the anal X and the r. post. R are separated by a pentagonal RA; whereas in *N. pachydactylus* the RA is quadrangular and the anal and r. post R are in contact. The high number of plates in the IBr series also suggest *Culmicrinus* of Jaekel[5] which, however, has a round stem, more cuneate brachials, with the calyx plates not depressed in the angles. Unfortunately none of the specimens at hand show any of the ventral sac other

[4]Jaekel, Phylogenie und System der Pelmatozoen, p. 54, Fig. 42, 1918.
[5]Ibid. p. 62, Fig. 53.

than the basal tube plates. This fact may be taken as strengthening the resemblance to *Nassoviocrinus* since if the present form had a large ventral sac such as typifies *Culmicrinus*, the preservation of one of the specimens at hand is such that at least a part of it would most certainly be shown, whereas the small ventral sac of *Nassoviocrinus* might easily be concealed. Specific name given in honor of Dr. Winifred Goldring whose Monograph on the Devonian Crinoids of New York has proved very helpful.

Occurrence.—Confined to the various members of the Trigonotreta zone, being most common in the Nassoviocrinus zonule at Nora Springs.

Holotype.—No. 1981; *Paratype.*—No. 1983, C.H.B.

Class ECHINOIDEA

Throughout the different members of the Lepidocentrus zone, at the top of the Mason City substage, there is to be found an abundance of echinoid remains. While as yet no complete, or partially complete, specimens have been found, the general character of these fossils is known from several hundred separated parts. These seem to represent the full complement of the divisions of the echinoid test. Upon these dissociated parts the following descriptions are based.

LEPIDOCENTRUS ? THOMASI N. SP.

Plate XIII, Figs. 1-16.

Description.—Ambulacral plates small, paddle-shaped, their height about one-half their width. Pore-pair rather large, slightly oblique, subcentrally located, occupying one-third or more the diameter of the plate; peripodium strong, edges angular, almost wholly surrounding the pore-pair. The outer surface of the plate bears one small perforate tubercle, located subcentrally at the narrower end of the plate and surrounded by a narrow basal terrace. The narrower end of the plate is produced into a straight slender process from one-half to two-thirds the length of the plate.

This process, as viewed from the side, is bent downward and apparently aided in imbrication. For it the term *imbricating process* is here used. Inner surface of the plate marked by a low subangular ridge, being an inward extension of the imbricating process, and continuing toward the center of the plate where it is deflected and passes between the pores to the margin of the plate. The total length of a typical plate is 4.9 mm and the height 2.0 mm.

Interambulacral plates subquadrate to subrhomboidal in outline, wider than high. Adoral margins thin and distinctly beveled; adoral suture well defined, the bevel rather abrupt, its width from one-fourth to one-seventh of the plate, the proportion being correspondingly greater on the smaller plates. Primary tubercle prominent and submarginal; mamelon round, perforated by a rather large circular foramen; neck varying from slightly undercut to a gradual slope outward and downward; flush platform rarely shown. Primary tubercle surrounded by a basal terrace the diameter of which is about three times the width of the tubercle; the margins of the terrace slightly elevated; surface of the terrace gently concave, with the curvature increasing toward the tubercle. On the smaller plates no terrace is shown. Secondary tubercles apparently imperforate, sometimes absent on the smaller plates, from one to eleven in number on the larger plates; irregularly scattered over the surface of the plate, rarely showing a tendency to form a more or less definite scrobicular ring.

Primary spines of varying sizes to correspond with the plates; uniformly slender, circular in cross-section, each terminating in a rounded or acute point, annular ring obscure. Bottom of the spine flat, its width about two-thirds the greatest diameter of the spine, marked centrally by a round, moderately deep acetabulum. Base of the spine comparatively short, expanding gradually and uniformly to the position of the annulus. Surface of the spine above the

position of the annulus marked by from 18 to 24 strong, rounded striæ or flutings.

Lantern moderately low and wide angled, the foramen magnum moderately deep, its depth being about one-fourth the height of the lantern, its width about two-thirds its depth. Maxilla strong and heavy, the peripheral surface convex and marked by a deep angular retractor scar. Tooth ridge prominent on the inner surface. Attachment of the epiphysis marked by but one narrow groove on the dorsal surface. Epiphysis narrow, very slightly arched. Rotula rather slender, notched at each end. Teeth strongly curved longitudinally, broadly V-shaped in cross section with the peripheral surface broadly rounded transversely and limited laterally by a shallow submarginal groove; adoral end of tooth with sharp edges meeting at an angle of about 80 degrees.

Remarks.—The genus *Lepidocentrus* has hitherto been represented in the American Devonian by but one species, *L. drydenensis* (Vanuxem), although some four species are known in the German Devonian. The reference of the present species to the genus *Lepidocentrus* is provisional since it differs in many important features from the genotype and other previously described members of the genus.

This species is named in honor of Dr. A. O. Thomas of the Iowa Geological Survey, whose paper on the Echinoderms of the Iowa Devonian has furnished the terminology and mode of description followed in the two echinoids here described.

Occurrence.—Restricted to the Lepidocentrus zone, being most common in the Camarophoria zonule at Nora Springs.

Cotypes.—(Iamb. plates) No. 1808, C.H.B., No. 1498, U. C.M., and No. 71032, U.S.N.M., where also there is a representative lot of spines and parts of the lantern.

DEVONOCIDARIS JACKSONI THOMAS

Plate XIII, Figs. 17-28.

Devonocidaris jacksoni Thomas, Echinoderms of the Lime Creek beds of Iowa. 13th page, 1923.

Devonocidaris jacksoni Thomas, Ia. Geol. Surv. vol. 29, pp. 500-505, pl. 50, fig. 36; pl. 51, figs. 1-26; pl. 52, figs. 1-4; pl. 53, figs. 1-7; pl. 54, figs. 1-6. 1924.

Remarks.—This species, the genotype, was described from a large number of dissociated parts found in the central portion of the Cerro Gordo substage of the Hackberry (Devonocidaris zonule). Although in the description of the interambulacral spines Dr. Thomas states correctly that the number of vertical striae is from 25 to 35, yet the enlargement shown in figure 12 of Plate 51 indicates a much smaller number. This is here mentioned so that there may be no confusion with the spines of *D. primaevus* described in this paper. Figures of some typical plates and spines of *D. jacksoni* are here included for comparison.

DEVONOCIDARIS PRIMAEVUS N. SP.

Plate XIII, Figs. 29-34.

Description.—Interambulacral plates very thin and fragile, slightly thicker at the center than toward the margins; their outlines hexagonal on the most perfect of the plates shown, the majority being incomplete. Imbrication uncertain, although one or two of the plates appear to bear traces of an adoral bevel, this feature may be due to distortion of the thin margins. Primary tubercle rather prominent, varying in position from subcentral to marginal. Mamelon round, apparently not undercut, perforated centrally by a deep round foramen; neck straight or sloping steeply downward and outward to the level of the plate. On several of the plates a low but distinct basal terrace is shown surrounding the primary tubercle, but on the majority of the plates this feature is absent. Secondary tubercles about one-third the size of the primary tubercles varying in number from 1 to 5 or sometimes absent; generally more or less closely grouped around the primary tubercle but not forming a definite scrobicular ring. Each of the secondary tubercles is perforate, and most of them are surrounded by a narrow basal terrace.

Primary spines straight, very slender, circular in cross section, terminating in an acute point. Base rather short, enlarging rapidly to the annulus above which the spine contracts somewhat more gradually for about a tenth of its length. Surface of the shaft marked by from 22 to 28, fine, rounded, slightly flexuous vertical striæ which end abruptly at the annulus.

The lantern apparently is low and wide-angled; the foramen magnum being very large, its depth equalling about one-third the height of the maxilla while its width is but slightly less. The peripheral surface of the maxilla is strongly convex and marked by a deep subangular retractor scar which occupies nearly the entire face. On the inner surface the tooth slide is prominent and the scars of attachment of the epiphysis occupy nearly all of the dorsal surface. The rotulæ are long, slender and slightly curved. The teeth are strongly curved longitudinally, the inner surface flat, the outer surface marked by two strong rounded ridges separated by an angular groove; adorally the tooth is produced into a sharp cuneate process on either side of which is a similar but much smaller process.

Remarks.—As in the case of *Lepidocentrus ? thomasi*, no complete specimens of *Devonocidaris primaevus* are known, although, with the exception of the ambulacral plates, the different parts are represented by hundreds of specimens. Close study of these, in comparison with similarly dissociated parts of the genotype, *D. jacksoni* Thomas, from the Cerro Gordo substage, shows a remarkable parallelism in general features although the corresponding parts of each species show minor differences which serve to distinguish them. The diagnostic character of the interambulacral plates of *D. primaevus* lies in the larger, more numerous secondary tubercles and in the weakly developed basal terrrace of the primary tubercle. The spines have fewer and heavier striae than those of *D. jacksoni* and the rotulae and teeth are more slender than those of the Hackberry form. The hemipyramids of the present species are very short, indicating a low, broad lantern.

Occurrence.—Confined to the Lepidocentrus zone, being most common in the Eatonia zonule of the Baumgardner phase. It is sparingly found in the Camarophoria zonule at Nora Springs.

Cotypes.—(Iamb. plates) No. 1738, C.H.B., No. 71033, U.S.N.M., and No. 1497, U.C.M.

Phylum MOLLUSCOIDEA
Class BRACHIOPODA

CRANIA MILLEPUNCTATA N. SP.

Plate XII, Figs. 4-6.

Description.—Shell subcircular to suboval in outline, generally distorted in growth so that the proportions of length and width are highly variable. Dimensions of a nearly complete brachial valve,—the holotype: width 8.7 mm; length 7.1 mm; height, 2.8. mm.

Pedicle valve unknown. Brachial valve irregularly subconical. The apex bluntly pointed, varying in position from central to a point one-third the diameter from the posterior margin, generally more or less inclined posteriorly. Surface slopes sharply to the posterior and less sharply to the anterior and lateral margins, on some specimens the surface anterior to the apex is gently convex. Surface marked by strong striæ numbering from 3 to 5 in the space of 1 mm. The striæ increase by intercalation, and on small specimens have a uniformly radial arrangement. On most specimens over 5 mm. in diameter, however, the striæ lose their regularity and in groups of 5 to 12 they are abruptly deflected to the right or left. In the areas vacated new sets originate which are deflected at high angle to the first group and which extend until they meet a set similar in direction to the first group. This irregular deflection apparently does not affect the posterior slope. Numerous alternately coarse and fine concentric wrinkles impart a crenulate appearance to the striæ.

Anterior adductor scars prominent, suboval, rather strongly elevated, their diameter as much as one-fifth of the diameter of the shell. In most cases they are located on either side of the apex, being separated by a narrow interval. Posterior adductor scars about one-fourth the size of the anterior; they are somewhat depressed in the shell floor and lie close together near the posterior margin. Entire inner surface of the valve marked by crowded punctæ, large enough to be readily visible.

Remarks.—This description is based upon nearly one hundred isolated brachial valves. Radiating striae mark such other Devonian species of *Crania* as *C. crenistriata* Hall, *C. bordeni* Hall, and *C. stewarti* F. & F. None of these, however, show the irregularly divergent striae such as characterize *C. millepunctata*. This can hardly be regarded as an accident of growth since fully 90 per cent of the larger specimens show this feature. The large closely arranged punctae are also specifically important.

Occurence.—Abundant in the Crania zonule of Ulster township, Floyd Co., Iowa.

Holotype.—No. 60; *Paratypes.*—Nos. 61, 62, 64, C.H.B., and No. 1496, U.C.M.

SCHIZOPHORIA FLOYDENSIS N. SP.

Plate XIV, Figs. 1-7.

Description.—Dimension of the holotype and of a paratype: width 29 and 25 mm.; length 23.5 and 19 mm.; thickness 17 and 14 mm.; width of cardinal area, 15 and 14 mm.; height of cardinal area 5.5 and 4.5 mm.

Pedicle valve depressed convex, its surface arching gently to the anterior and rather sharply to the cardinal margins, but sloping gradually to the lateral margins. Mesial sinus originates about one-fourth of the distance anterior to the beak; at the margin it forms a broad rounded depression nearly one-half the depth of the opposite valve. Beak prominent, moderately incurved; cardinal area large, its width more than half that of the valve; increasingly con-

cave toward the beak; its lower portion posteriorly inclined at an angle of about 120 degrees to the plane of the valve. Delthyrium large, nearly twice as high as wide. Internally, strong hinge teeth are supported by short, stout dental lamellæ which continue forward as two high, sharp ridges bounding the muscle scars. Muscular area about one-third the length of the valve, divided by a low subangular ridge which originates near the antero-median emargination, and extends less than half the distance to the beak, gradually merging with the shell floor.

Brachial valve convex, its surface arching sharply and uniformly from the beak to the anterior and less sharply to the lateral and cardinal margins. Mesial fold obsolete or indicated only by a slight flattening of the shell. Cardinal area less than one third the height of that of the pedicle valve, its upper portion slightly concave. Beak small, obtuse. Internally, the socket plates are very prominent and are supported by stout lamellæ that extend as sharp ridges bounding the muscle scars. Muscular area large, subquadrate, its anterior half divided by a slender median ridge which originates just anterior to the emargination; cardinal process large, sharply angular, continuing forward as a ridge, nearly meeting the median muscular ridge.

Surface of both valves marked by fine, rounded, tubular costæ, from 1 to 4 in the space of 1 mm.; they increase by bifurcation and intercalation, and alternate ones are considerably larger than those between. Costæ crossed by strong irregularly spaced growth constrictions between which are numerous and finer concentric lines.

Remarks.—This species differs from other members of the genus known from the Iowa Devonian in its much wider and higher cardinal area and in the more prominent pedicle beak.

Occurrence.—One of the most common forms of the Schizophoria zone, being found abundantly in all of the eastern members of that zone. It also occurs more or less commonly in the Prismatophyllum zonule of the Nora substage at Rudd.

Holotype.—No. 500; *Paratypes.*—Nos. 276, 375, 362, C.H. B., and No. 71040, U.S.N.M.

STROPHEODONTA CICATRICOSA N. SP.

Plate XIV, Figs. 11-14.

Description.—Shell subquadrate in outline; greatest width ranging from the hinge line to near the mid-length. Dimensions of the holotype and of a paratype: width 17.5 and 14 mm.; length 15 and 12.5 mm.; thickness 6.5 and 6 mm.

Pedicle valve with the greatest convexity near the mid-length, its surface arching gently from the beak to the anterior, and less strongly to the lateral and cardinal margins. Beak small, blunt, incurved; cardinal area broadly triangular, flat or slightly concave, inclined posteriorly and lying nearly in the plane of the valve; marked by fine vertical striæ. Delthyrium obsolete externally. Internally, the grooves for the cardinal apophyses are deep. Muscular area large, depressed, indistinctly bounded; divided medially by a low sharp ridge which originates shortly anterior to the cardinal, and continues more than half the distance to the anterior margin. A subangular thickening about 2 mm. wide extends around the lateral and anterior margins, being most prominent near the extremities.

Brachial valve most concave near the beak, and flattened toward the extremities where its surface is nearly flush with the cardinal margin. A sulcus extends from the beak to the anterior margin, becoming broad and shallow anteriorly. Cardinal area less than half as high as that of the pedicle valve, flat, inclined anteriorly at about 60 degrees to the plane of the valve and marked by vertical crenulations. Internally, the cardinal process is small and bifid; the apophyses are widely separated and subparallel. Muscular area strongly elevated; posterior adductor scars bounded posteriorly by heavy crescentic ridges which together are more than twice as wide as the base of the cardinal process. A low subangular median ridge extends to

the raised rim bordering the valve. Anterior adductor scars bounded by curved ridges which originate near the lateral extremities of the posterior scars and extend nearly to the middle of the valve, where they converge with the mesial ridge. About 2 mm. within the anterior and lateral margins is a rounded shelf-like ridge upon which vascular sinuses are strongly impressed. Beyond this the inner surface curves sharply downward to the margins.

Surface of both valves marked by low, subangular radiating costæ which increase by bifurcation and intercalation; from 1 to 3 in the space of 1 mm. The costæ are crossed by fine concentric growth lines which are most conspicuous on the pedicle valve Shell thick and coarsely punctate.

Remarks.—Externally this species bears a strong resemblance to certain members of the genus *Douvillina* although the internal structure is that of *Stropheodonta.* There is no described species from the Iowa Devonian which approaches this in the extremely heavy character of the muscle scars.

Occurrence.—Very abundant in the Camarophoria zonule at Nora Springs, but more or less common in all of the members of the Lepidocentrus zone.

Holotype.—No. 242; *Paratypes.*—Nos. 349, 356, 409, 176, C.H.B., No. 71038, U.S.N.M., and No. 1499 U.C.M.

STROPHEODONTA SCOTTENSIS N. SP.

Plate XIV, Figs. 8-10.

Description.—Shell strongly convex, about two-thirds as long as wide, with greatest width along the hinge line. Cardinal extremities angular, generally produced into small auriculations not sharply set off from the body of the shell; lateral margins straight or slightly concave posteriorly, becoming more convex anteriorly and passing without break into the regularly curved anterior margin. Dimensions of the holotype and of a paratype: width 39 and 46 mm.; length 26 and 33 mm.; thickness 12 and 16 mm.

Pedicle valve deepest posterior to the midlength, most convex near the beak, its surface arching gently to the an-

terior margin. Cardinal extremities arched or very slightly flattened. Surface marked by moderately strong subangular costæ which are slightly flexuous near the margins and extremities, and which increase by bifurcation and intercalation; averaging about 7 in the space of about 5 mm. Beak large, blunt, slightly incurved. Cardinal area low, flat or very slightly concave, and lying about in the plane of the valve; transversely striated. Delthyrium externally obsolete.

Brachial valve moderately concave, with shallow sulci extending toward the extremities just anterior to the cardinal margins. Surface marked by costæ similar to those of the pedicle valve, but much weaker. Cardinal area transversely striate, sublinear, its surface flat and standing about at right angles to the plane of the valve. Internally, the inner face of the cardinal border is strongly crenulated throughout its entire length, the crenulations not encroaching on the cardinal area. Cardinal apophyses large, elevated and strongly divergent, extending beyond the cardinal line, their extremities notched. Muscular area large, situated on a strongly elevated platform whose lateral margins are sharply defined by curved ridges which originate slightly anterior to the base of the apophyses and continue forward about one-third of the length of the valve where they converge and unite to form a strong rounded ridge which continues nearly to the front of the valve. Muscular area at the point of greatest width bears four faintly rounded subparallel ridges which extend from near the anterior margin of the area to the base of the apophyses. Shell thick, strongly punctate.

Remarks.—The strongly elevated muscular area distinguishes the present species from any other large *Stropheodonta* known in the Iowa Devonian.

Occurrence.—Restricted to the Trigonotreta zone, being most common in the Bactrocrinus and Stropheodonta zonules at Rockford and in the Cyrtoceras zonule at Nora Springs.

Holotype.—No. 300; *Paratypes.*—Nos. 1088, 174, 542, C. H.B., and No. 71031, U.S.N.M.

PRODUCTELLA FRAGILIS N. SP.

Plate XIV, Figs. 15-17.

Description.—Length about three-fourths the width; greatest width near the midlength: cardinal extremities rounded. Dimensions of the holotype: length 14.2 mm.; width 18.7 mm.; thickness 7.3 mm.

Pedicle valve strongly convex, prominent umbonally. Surface arching gently from the beak to the anterior margin with the greatest curvature posteriorly; rather strongly arched from the umbo to the cardinal margins; more gently to the lateral margins, which toward the extremities are sharply deflected and produced below the plane of the valve. Lateral extremities separated from the main body of the shell by a shallow sinuosity that is most marked toward the cardinal margins. Beak small, inconspicuous. Cardinal area low, well defined, triangular. Delthyrium closed by a low deltidium.

Brachial valve deeply concave in the visceral portion; deflected and somewhat flattened toward the cardinal extremities. Cardinal area linear. Internally, the cardinal process is small; the apophyses are rounded and lie nearly at right angles to the shell floor. A faint median ridge extends from near the base of the apophyses to beyond the middle of the valve.

Surface of both valves marked by strong concentric wrinkles which are most conspicuous on the brachial valve. On the pedicle valve they are strong toward the extremities and almost obsolete on the anterior and central portion. Spine bases developed only on the pedicle valve; they number from 30 to 50 and are small and irregularly spaced, being most conspicuous toward the cardinal margins where from 3 to 5 appear on each side of the beak. Shell of both valves very thin and fragile.

Remarks.—The most nearly related form from the Iowa Devonian is *Productella subalata* (Hall) of the Cedar Valley. In it the pedicle beak is prominent, the spine bases are heavy and show a tendency to concentric arrangement, and the con-

centric wrinkles are very heavy and strongly undulating. The cardinal area is linear while on *P. fragilis* it is distinctly triangular; thus resembling some of the Mississippian species of *Productus*.

Occurrence.—Especially abundant in the Productella zonule at Rudd. The same, or closely related form, is common in the Eatonia zonule in the Baumgardner phase and in the Cyrtoceras zonule at Nora Springs.

Holotype.—No. 130; *Paratypes.*—Nos. 390, 299, 232, C.H. B., No. 1493, U.C.M., and No. 71365, U.S.N.M.

CAMAROPHORIA PAUPERA BELANSKI

Plate XIV, Figs. 18-26.

Camarophoria paupera Belanski. Bull. State Univ. Iowa Studies in Nat. Hist. vol. XII, No. 7. p. 27, Pl. IV, figs. 6-14. 1928.

Description.—Shell small, subtriangular to sub-pentagonal in outline. Dimensions of the holotype and a paratype: length 6.3 and 7. mm.; width 7.6 and 8.5 mm.; height 5 and 6.2 mm.

Pedicle valve moderately convex, with the greatest curvature slightly posterior to the midlength. Surface arching gently toward the anterior and antero-lateral margins for about two-thirds the length of the shell, then is abruptly deflected; gently and uniformly arched to the postero-lateral and cardinal margins. Beak conspicuous, acutely pointed, incurved. Sinus originates near the midlength as a rounded depression which broadens and deepens anteriorly and is produced in a broad subquadrate lingual extension which is nearly at right angles to the plane of the valve. Anteriorly it bears one low subangular plication; this may bifurcate on very large specimens and from two fainter ones; the sinuses of small specimens may be nonplicate. Each lateral slope bears two, or rarely three, subangular plications which at the front of the shell are strongly elevated,—the central pair in some cases as much as 2 mm. Internally, a strong median septum reaches nearly to the

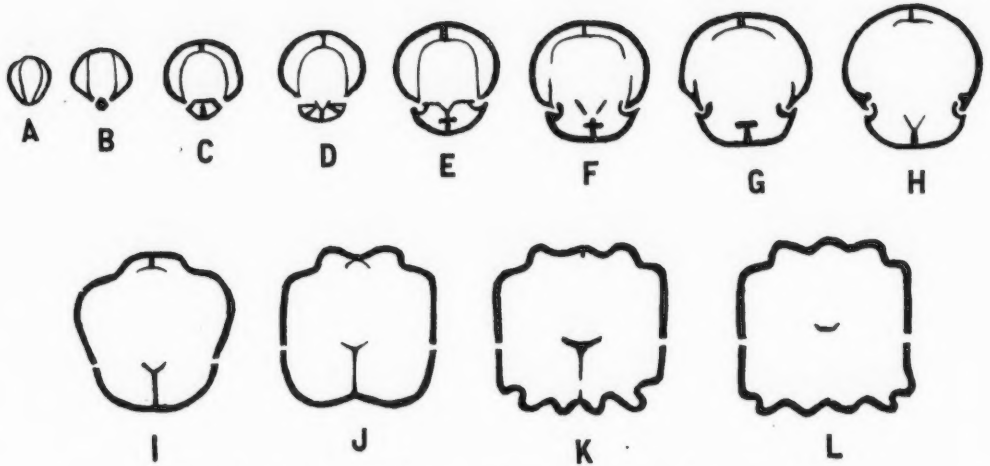

Fig. 2.—A series of 12 cross-sections of the rostral portion of the shell of *Camarophoria paupera*, showing the dental lamellae and spondylium of the pedicle valve; and the median septum, hinge plate and cruralium of the brachial valve. x6.

front, and supports the spondylium for more than half the distance.

Brachial valve slightly less convex than the pedicle, with its greatest curvature in the umbonal region. The surface arches gently to the postero-lateral and cardinal margins but is abruptly deflected near the anterior margin with the surface between the plications produced in sharp, cuneate, lingual extensions. Fold originates near the mid-length, where it is abruptly defined by angular grooves, although at the anterior margin its crest is at about the general level of the valve. Mesially it bears a shallow, subangular furrow which may reach the umbo. Each lateral slope bears two sharply angular plications which are separated by deep subangular furrows; plications lacking on the posterior half of the valve. Internally, a stout median septum supports the hinge plate and cruralium and reaches nearly to the front of the valve. The cruralium is heavy and extends forward more than two-thirds of the distance to the front of the shell, its anterior portion strongly elevated. Surface of both valves marked by faint concentric growth wrinkles which are especially prominent upon the reflected anterior portions.

Remarks.—In the reflected anterior margins of its valves and in its angular and strongly elevated plications, *Camarophoria paupera* differs markedly from any other Devonian member of the genus. *C. swallovi* (Branson) has reflected margins but in every case they are more rounded, and its plications are low and rounded and much more numerous than in *C. paupera.*

Occurrence.—Confined to the Camarophoria zonule, being especially common at Nora Springs. It has been found also at Rockford, as well as in the Sherman Bluff phase.

Holotype.—No. 10; *Paratypes.*—Nos. 15, 16, 18, 20, C.H. B., No. 1494, U.C.M., and No. 71027, U.S.N.M.

EATONIA GREGARIA N. SP.

Plate XV, Figs. 7-17.

Description.—Shell wider than long, with greatest width, at, or slightly posterior to the midlength. Dimensions of the holotype: length 12 mm.; width 15 mm.; thickness 9.5 mm.

Pedicle valve strongly convex with the greatest convexity posterior to the midlength; surface arching strongly from the umbonal region to the anterior and lateral margins, and sloping rather sharply to the cardinal margins. Beak small, rather blunt, incurved, pierced just below its extremity by a small circular foramen. Sinus originates slightly posterior to the middle of the valve; it forms a broad shallow depression which is well defined anteriorly and produced into a long lingual extension lying at a high angle to the plane of the valve. Anteriorly the sinus bears from 3 to 5 low, subangular plications, the central one originating near the midlength, those on the sides appearing progressively farther anteriorly, the increase being by intercalation. Each lateral slope bears from 1 to 3 similar plications, those on either side of the sinus being much the strongest. Internally, the hinge teeth are strongly developed but are not supported by dental lamellæ.

Brachial valve nearly as convex as the pedicle with the greatest curvature posterior to the midlength. Surface arching gently from the beak to the anterior margin, and sloping rather sharply to the lateral and cardinal margins. Beak small and incurved, concealed by that of the pedicle valve. Fold broad, flattened, originating about one-third the distance anterior to the beak and rather strongly elevated anteriorly; in specimens of average size it is divided by a shallow groove originating near the middle of the valve, but in larger specimens it may have as many as five plications. Each lateral slope bears 2 to 3 rounded plications that originate near the midlength. Internally, a very

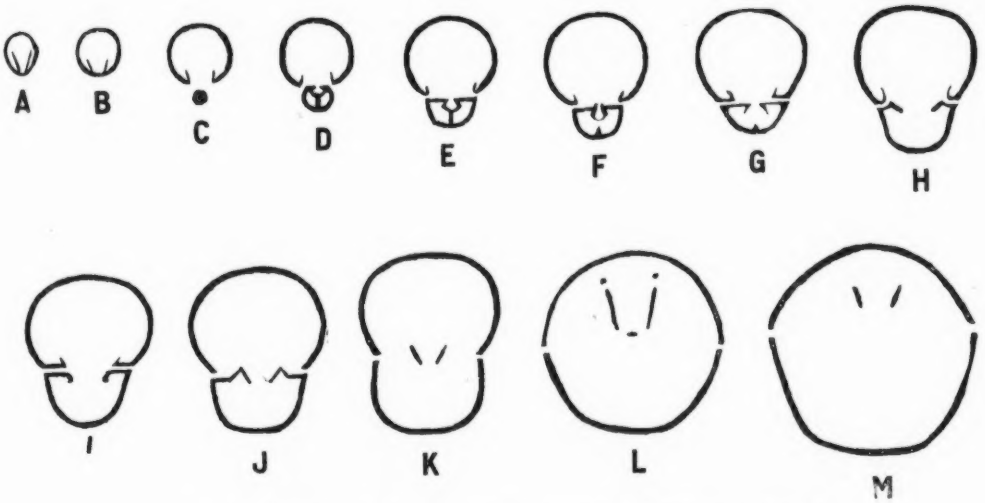

Fig. 3.—A series of 13 cross sections from the rostral portion of the shell of *Eatonia gregaria*, showing the unsupported teeth of the pedicle valve, and the median septum, crural cavity and crura of the brachial valve. x4.

short median septum is developed; the hingeplate is short and divided by a narrow crural cavity and is supported by the median septum for a very short distance.

Surface marked by very fine concentric growth lines. On the holotype there appear to be interrupted radiating striæ. These have been observed on no other specimen and their appearance here may be due to weathering.

Remarks.—This species apparently has no related form in the Iowa Devonian. Externally it bears considerable resemblance to *Eatonia variabilis* Whiteaves from the Hay River district of Canada. The internal character of the Canadian form, however, indicates a different genus from that to which it was originally referred.

Occurrence.—Particularly abundant in the Eatonia zonule in the Baumgardner phase where dozens of specimens may be obtained.

Holotype.—No. 1323; *Paratype.*—Nos. 1193, 1322, C.H.B. No. 71039, U.S.N.M., and No. 1441, U.C.M.

HYPOTHYRIDINA MAGISTER N. SP.

Plate XV, Figs. 1-6.

Description.—Shell subpentagonal to subcircular in outline, nearly as long as wide, with the greatest width at or slightly posterior to the midlength. Dimensions of the (exfoliated) holotype: width 33 mm.; length 31 mm.; thickness 26 mm.

Pedicle valve depressed convex, with the greatest convexity slightly anterior to the beak; its surface arches gently from the beak to the antero-lateral margins but slopes gently to the lateral margins, slightly depressed near the posterior margins. Beak small, pointed, strongly incurved, pierced at its extremity by a small circular foramen beneath which is a triangular deltidial plate; these are best seen in sections. Sinus originates about one-fourth the distance anterior to the beak; broad and poorly defined on the central portion of the valve; anteriorly produced into a broad, subquadrate lingual extension at nearly right

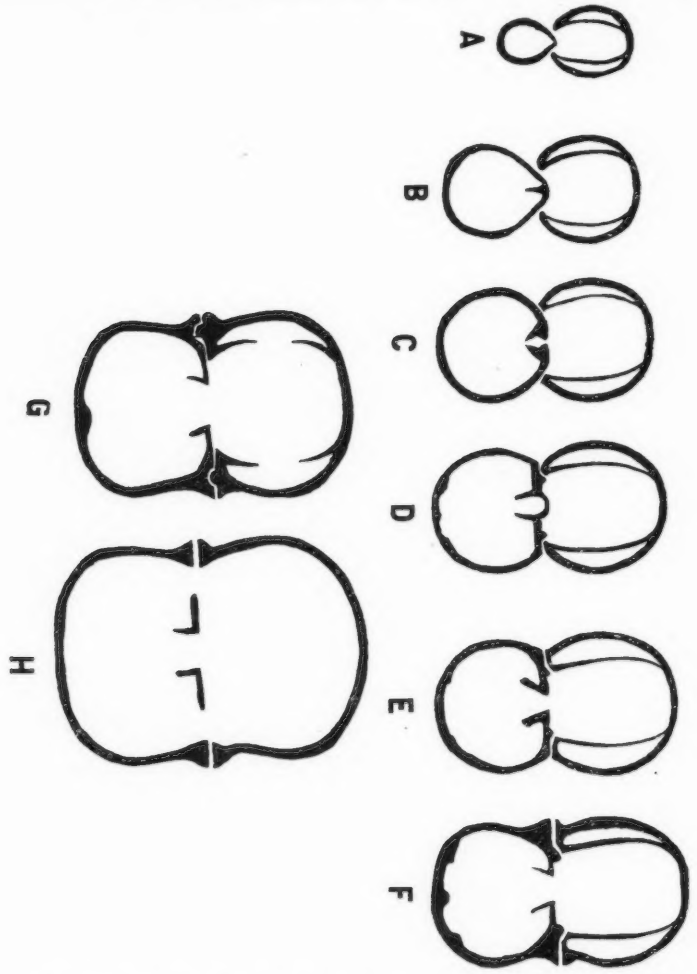

Fig. 4.—A series of 8 cross-sections from the rostral portion of the shell of *Hypothyridina magister*, showing the teeth and dental lamellae of the pedicle valve, and the crural cavity and crura of the brachial valve. Note the absence of a median septum in the brachial valve. x2.

angles to the plane of the valve. Surface marked by 22 to 26 strong, subangular plications which are faint or lacking on the posterior portion of the valve; of these 8 to 9 are on each lateral slope and 6 to 8 in the sinus; those on the slopes apparently are simple whereas a few of those in the sinus bifurcate. Internally, the hinge teeth are strong and are supported by short, thin dental lamellæ.

Brachial valve more convex than the pedicle, with the greatest convexity posterior to the midlength; its surface curves sharply to the lateral and cardinal margins. Beak small, pointed, incurved, largely concealed beneath that of the pedicle valve. Fold broad, flattened, rather low; originating slightly posterior to the midlength, where it is poorly defined; elevated anteriorly with its lateral margins sloping sharply down to the shell surface. Plications correspond in number and size to those of the pedicle valve. Internally the hinge plate is divided by a narrow, linear crural cavity: the rudimentary median septum does not support the hinge plate since it is elevated but little above the shell floor. Surface marked by fine, rather sharp, concentric growth lines which arch slightly backward over the plications.

Remarks.—This species apparently has no close relative in the Iowa Devonian. The only other member of this genus which is known to occur in Iowa is the Upper Davenport form, referred to *Hypothyridina cuboides* (Sowerby). This is much smaller, more quadrate in outline and with more numerous and much weaker plications.

Occurrence.—Confined to the Lepidocentrus zone, and particularly common in the Camarophoria zonule at Nora Springs. Due to its large size and fragile shell it is generally found as fragmentary valves or occasional complete but crushed specimens.

Holotype.—No. 935; *Paratypes.*—Nos. 1255, 1711, 462, C.H.B., No. 71044, U.S.N.M., and No. 1492, U.C.M.

SPIRIFER CARDINALIS N. SP.

Plate XVI, Figs. 23-30.

Description.—Shell semi-circular to subtriangular in outline, wider than long, with the greatest width along the hinge line. Cardinal extremities sharply angular in immature specimens, becoming relatively more obtuse with advancing age. Dimensions of the holotype and of a paratype: length 14.5 and 15 mm.; width 18.7 and 24. 5 mm.; height 11.4 and 12 mm.

Pedicle valve strongly convex with the greatest convexity anterior to the middle. Surface arching gently from the beak to the anterior margin, more strongly to the anterolateral margins, and sharply to the cardinal margins; the cardinal extremities slightly produced and bearing shallow sulci slightly anterior to the cardinal margins. The sinus originates near the beak as a subangular depression which becomes broader and deeper anteriorly, its floor flattened at the front of the shell; normally it is non-plicate but rarely bears a faint plication in the bottom. Beak of moderate size, obtusely pointed slightly incurved. Cardinal area triangular, three times as wide as high, gently concave, its lower portion nearly vertical, marked by fine vertical striae and by transverse wrinkles. Lateral margins of the area sharply defined and subparallel with the cardinal margin for about one-third their length. Delthyrium nearly twice as high as wide, with no apical callosity or deltidial plate. Internally, the hinge teeth are strong and are supported by stout lamallae which extend about one-third the distance to the front of the valve.

Brachial valve most convex just anterior to the beak, its surface arching gently to the anterior and lateral margins; cardinal extremities slightly depressed and marked by sulci similar to those of the pedicle valve. The fold originates as a rounded elevation near the beak becoming moderately elevated and flattened anteriorly, well defined for its entire length. Beak small, blunt, strongly incurved. Cardinal area narrow, divided by a triangular delthyrium.

Plications similar to those of the pedicle valve. Internally, the dental sockets are strong and moderately divergent. The muscular area is small and weak.

Surface of both valves marked by sharp, concentric, lamellose growth lines which average about 3 in the space of 1 mm. These are very conspicuous on the fold and sinus.

Remarks.—In general shape and surface markings this species suggests *Spirifer inutilis* Hall of the Cedar Valley; but that species has a stout deltidial plate, whereas in *S. cardinalis* the delthyrium is open. This feature points to generic rather than specific difference between the two forms.

Occurrence.—*S. cardinalis* is particularly common in the Eatonia zonule, from which the types are taken. A form with more rounded cardinal extremities is equally common in the Camarophoria zonule at Nora Springs. Apparently varietal forms are more or less common in several other zonules of the Shellrock.

Holotype.—No. 969; *Paratypes.*—Nos. 315, 370, C.H.B., No. 71364, U.S.N.M., and No. 1495, U.C.M.

TRIGONOTRETA SHELLROCKENSIS N. SP.

Plate XVI, Figs. 11-18.

Description.—Shell semicircular in outline with greatest width at, or just anterior to the hinge line; cardinal extremities angular or very slightly rounded. Dimensions of the holotype and of a paratype: width 17 and 17 mm.; length 13 and 12 mm.; height 12 and 13 mm.; height of cardinal area 8 and 7.5 mm.

Pedicle valve subpyramidal, the surface sloping sharply from the beak to the anterior and lateral margins. Sinus originates near the beak; well defined, produced into a short, rounded lingual extension. Bottom of the sinus gently rounded, bearing 5 to 7 strong, rounded plications, of which only the outer 1 or 2 are simple, the others arising by repeated bifurcation of the central one. Each lateral slope bears 15 to 17 strong, rounded, simple plications,

those bounding the sinus being coarser than the others, those toward the extremities are fine and somewhat flexuous. Beak small, pointed, slightly incurved, projecting well beyond the cardinal line. Cardinal area moderately curved and generally distorted, its width half again its height; its lower portion nearly vertical to the plane of the valve or slightly inclined anteriorly; lateral margins well defined; surface marked by fine vertical striae and fine transverse growth wrinkles. Delthyrium twice as high as wide. Internally, the hinge teeth are supported by short, moderately divergent dental lamellae. The apical sixth of the delthyrium is filled by a stout, convex deltidial plate.

Brachial valve depressed convex, most prominent in the middle; its surface arching gently from the beak to the anterior and lateral margins and slightly flattened near the cardinal extremities. Fold originates near the beak and is bounded for the most of its length by a pair of furrows which are somewhat deeper than those between the plications; its top is gently rounded. Beak small, inconspicuous; cardinal area very narrow, divided by a rather broad delthyrium.

Surface marked by fine concentric growth lines which impart a faintly crenulate appearance to the plications. Some specimens show one or more stronger constrictions of growth, however, this feature is uncommon.

Remarks.—This species is intimately related to the genotype, *Trigonotreta aperturatus* (Schlotheim), from the German Devonian. The chief features distinguishing the two are the uniformly larger size of the German species, its more erect cardinal area, and the proportionately greater number of plications in the fold and sinus. As many as 17 plications have been counted on the fold of *T. aperturatus* whereas the greatest number noted on that of *T. shellrockensis* is 9.

Judging from Whiteaves' description (Cont. Can. Pal. Vol. 1, pt. 3, pp. 222-223, 1891), it appears that *T. shellrockensis* rather than *T. cyrtinaformis* (H. & W.) is the *Trigonotreta* found in the Devonian of the Hay River district of

Canada. *T. cyrtinaformis* is uniformly smaller than the present species and has nearly double the number of plications on each valve. In true *T. cytinaformis* the fold and sinus are very indefinitely bounded, whereas on *T. shellrockensis* both are sharply defined. Of the different species of *Trigonotreta* of the overlying Hackberry stage, the one most closely related to *T. shellrockensis* is *T. Foliose latimarginata* (F.&F.) which can readily be distinguished by its more elongate extremities and also by its high, nearly flat, anteriorly-inclined cardinal area.

Occurrence.—With the exception of the zonules of the Paracyclas zone, *T. shellrockensis* occurs more or less commonly in every member of the Shellrock. It is especially abundant in the Trigonotreta zone, particularly in the Bactrocrinus and Cyrtoceras zonules. The types are from the Bactrocrinus zonule.

Holotype. — No. 720; *Allotype.* — No. 728; *Paratypes.* — Nos. 2242, 1799, C.H.B., and No. 71028, U.S.N.M.

PLATYRACHELLA BALLARDI N. SP.

Plate XVI, Figs. 1-10.

Description.—Shell wider than long, with greatest width slightly anterior to the hinge line; the cardinal extremities gently rounded. Dimensions of the holotype and of a paratype: width 18 and 22.5 mm.; length 11 and 14 mm.; height 13 and 14 mm.

Pedicle valve subpyramidal, its surface sloping with a slight curvature from the beak to the anterior and lateral margins. Sinus well defined, non-plicate, with broadly flattened floor; it originates near the beak and is produced into a short rounded or subquadrate lingual extension. Each lateral slope bears 10 to 12, low, rounded, simple plications; those near the extremities being smaller than the others. Beak prominent, pointed, very slightly incurved. Cardinal area moderately high, flat or very gently concave; in some specimens it is inclined anteriorly at an angle of 75 degrees to the plane of the valve; in other speci-

mens it is posteriorly inclined at an angle of as much as 120 degrees. Surface of the area marked by fine vertical striae. Delthyrium nearly twice as high as wide. Internally, the teeth are moderately developed and are supported by stout lamellae which extend anteriorly for nearly half the length of the valve. A stout transversely-convex delthyrial plate occupies the apical fourth of the delthyrium.

Brachial valve depressed convex, with the greatest convexity posterior to the middle; its surface curving gently to the anterior and to the lateral margins; in some cases flattened or depressed near the extremities. Fold originates near the beak; it is well defined throughout its length and moderately elevated anteriorly where its top is broadly flattened. Plications similar to those of the pedicle valve. Beak small, blunt, strongly incurved; cardinal area narrow; delthyrium broad. Internally, the dental sockets are prominent and strongly divergent. Muscular scars weak and poorly defined.

Surface marked by uniformly distributed, fine, radiating striae each of which bears a row of minute granules. These striae are very prominent in the furrows and upon the fold and sinus; those of the fold and sinus less granulose than those of the lateral slopes. Heavy growth constrictions cross the plications and well preserved specimens show much finer concentric lines.

Remarks.—The species is closely related to the genotype, *Platyrachella macbridei* (Calvin), differing largely in its uniformly smaller size and much coarser striae and granules,—*P. macbridei* having more than twice as many striae on each plication as has *P. ballardi.* In the former the lingual extension is rather long and rounded whereas in the latter it is short and subquadrate. In general shape *P. ballardi* resembles *Spirifer asper* Hall of the Cedar Valley, in which, however, the delthyrial plate is very different. Specific name in honor of Mr. H. G. Ballard of Rockford, Iowa.

Occurrence.—Confined to the Platyrachella zone; especially abundant in the Schuchertella zonule at Rockford, the types

being from this member. Specimens nearly twice the size of the Rockford forms are found in the central (Syringopora) member of this zone northwest of Nora Springs.

Holotype.—No. 277; *Paratypes.*—No. 702, 1042, 2185, C. H.B., and No. 71035, U.S.N.M.

PLATYRACHELLA ULSTERENSIS N. SP.

Plate XVII, Figs. 1-8.

Description.—Shell large, wider than long, with the greatest width along the hinge line; cardinal extremities obtusely to sharply angular. Dimensions of the holotype: width 58 mm.; length 32 mm.; thickness 30 mm.; height of cardinal area 12 mm.

Pedicle valve strongly convex, deepest umbonally; its surface arching rather sharply to the anterior margin, more gently to the antero-lateral and lateral margins, in some cases slightly flattened near the extremities. Sinus non-plicate, originating near the beak; shallow, rounded or broadly flattened but well defined, with a short, broadly rounded lingual extension, which as a rule is steeply inclined. Each lateral slope bears from 15 to 17, simple, broad, rounded plications which become progressively fainter toward the extremities, the last 4 or 5 being somewhat flexuous and those bounding the sinus are broader and flatter than the others. Beak large, obtuse, moderately incurved, projecting considerably beyond the cardinal line. Cardinal area large and rather high, its lower half nearly flat and inclined posteriorly, its upper portion increasingly concave; lateral margins well defined and in senile specimens subparallel with the cardinal margins near the extremities. Surface marked by fine vertical striae and by transverse lines and constrictions of growth. Delthyrium large, nearly as wide as high, its apical fifth filled by a stout, transversely-convex delthyrial plate. Internally, the teeth are prominent and are supported by stout, divergent dental lamellae, which continue anteriorly for nearly one-third the length. In well

preserved casts a thin, sharp, rather low median septum extends from the beak nearly to the midlength.

Brachial valve nearly as convex as the pedicle, with the greatest depth near the middle; its surface arches gently to the anterior, and sloping gently to the lateral and anterolateral margins, with the extremities depressed and in some cases flattened. Fold non-plicate, sharply defined to the beak; at first scarcely elevated but becoming more so anteriorly, where it is flattened or gently rounded. Plications correspond to those of the pedicle valve. Beak small, blunt, moderately incurved; cardinal area long and narrow; delthyrium broad. Internally, the socket plates are rather prominent and strongly divergent; the muscular area weak and poorly defined.

Surface marked by fine, flexuous rows of elongate granules which are highest at their anterior ends. They are most prominent on the fold and sinus and in the furrows, there being from 4 to 6 rows in the space of 1 mm. Crossing these rows are numerous growth constrictions, which are stronger and more numerous near the front of the shell.

Remarks.—*Platyrachella ulsterensis* closely resembles the form of *P. iowensis* (Owen) which is found near Independence, Iowa, but is distinguished by its smaller size, proportionately higher cardinal area, flattened fold and sinus, and flatter plications, and further by the absence of produced extremities. *P. ulsterensis* has a median septum in the pedicle valve; a feature never found in *P. iowensis*. Still other differences are found in the character of the finer surface markings of the two species.

Occurrence.—Abundant in the Ulsterensis zonule where it occurs as casts; more or less common throughout the Schizophoria zone in western Floyd County. Casts, apparently of this species, also occur in the shaly upper portion of the Platyrachella zone at Rockford. The types are from the Crania zonule.

Holotype.—No. 1905; *Paratypes.*—No. 647, C.H.B., and No. 71034, U.S.N.M.

PLATE XII

FIGURES PAGE

1. *Cylindrophyllum floydense* n. sp. ---- 176
Part of the upper surface of a large colony showing the irregular mode of growth. (2001 C.H.B.) x 1.

1. *Prismatophyllum oweni* n. sp. ---- 174
Upper surface showing the well defined calyces and deep central pits. (471 C.H.B.) x 1.

3. *Pachyphyllum websteri* n. sp. ---- 171
Upper surface of small corallum showing the short, closely crowded "rings", (2176 C.H.B.) x 1.

4— 6. *Crania millepunctata* n. sp. ---- 186

4. Brachial view of an imperfect specimen showing the strong radiating striae and their irregular arrangement. (60 C.H.B.) x 2.

5. Interior of a large and nearly complete brachial valve showing the muscle scars. (62 C.H.B.) x 2.

6. A portion of the same enlarged to show the abundant punctae. x 5.

PLATE XIII

1—16. *Lepidocentrus ? thomasi* n. sp. ---- 181

1—13. Interambulacral plates showing primary tubercle, basal terrace, adoral bevel, etc. Plates from both halves of the interambulacrum are shown. (1808 C.H.B.) x 3.

13—15. Lower, upper and lateral views of an ambulacral plate showing pore-pair, imbricating process, etc. (68 C.H.B.) x 4.

16. A portion of a primary spine showing the short base and strong vertical striae. (68-D C.H.B.) x10.

17—28. *Devonocidaris jacksoni* Thomas ---- 183

17—21. Five typical interambulacral plates showing strong basal terraces and weakly developed secondary tubercles. (3722 C.H.B.) x 3.)

22—27. Several ambulacral plates showing primary tubercles, horizontically arranged pore-pair, peripodium, etc. (3692 C.H.B.) x 5.

28. A portion of a primary spine showing the fine vertical striae, rounded annulus, etc. (3692 C.H.B.) x 10.

29—34. *Devonocidaris primaevus* n. sp. ---- 184

29. A typical primary spine showing the strong vertical striae. (674 A C.H.B.) x 10.

FIGURES PAGE

30—34. Five interambulacral plates. Note weakly developed basal terraces of the primary tubercles and numerous secondary tubercles which in Figs. 30 and 34 are surrounded by narrow basal terraces. (1738 C.H.B.) x3.

35—37. *Bactrocrinus westoni* n. sp. ---------- 177

35. View of an incomplete specimen from the right anterior side showing the quadrangular radial. Dotted lines indicate the relationships of the basals and infrabasals. (1982 C.H.B.) x 1.

36—37. Right posterior and right anterior views of a specimen composed of basals and infrabasals. Note the elongate basals. (1675 C.H.B.) x2.

38—39. *Nassoviocrinus goldringae* n. sp. ---------- 179

38. Anterior view of a nearly complete specimen showing numerous primibrachs, isotomous arms, etc (1981 C.H.B.) x 1.

39. Anterior view of another nearly complete specimen showing the plates of the calyx. Note depressions at the angles of the calyx plates, pentagonal stem, etc. (1983 C.H.B.) x 1.

PLATE XIV

1— 7. *Schizophoria floydensis* n. sp. ---------- 187

1— 4. Pedicle, anterior, brachial and lateral views of a nearly complete specimen showing the high cardinal area. (500 C.H.B.) x 1.

5. Posterior view of a somewhat smaller specimen showing the size of the cardinal area. (276 C.H.B.) x1.

6. View of the interior of a rather large pedicle valve showing the muscle scars; the apparent emargination at the front of the shell is due to breakage. (444 C.H.B.) x 1.

7. Interior of an incomplete brachial valve showing the cardinal process, muscle scars, etc. (443 C.H.B.) x 1.

8—10. *Stropheodonta scottensis* n. sp. ---------- 190

8— 9. Pedicle and brachial views of a nearly perfect specimen of normal size. (300 C.H.B.) x 1.

10. Interior of a large incomplete brachial valve showing the strongly elevated muscle scars, crenulate hinge line, etc. (174 C.H.B.) x 1.

FIGURES PAGE

11—14. *Stropheodonta cicatricosa* n. sp. ---------- 189

11. Pedicle view of a nearly perfect specimen of normal size. (242 C.H.B.) x 1.

12. Brachial view of a somewhat smaller specimen. 356 C.H.B.) x 1.

13. Interior of a large pedicle valve showing the low median septum. (176 C.H.B.) x 1.

14. Interior of a small brachial valve showing the muscle scars, vascular sinuses, etc. (176-B C.H.B.) x1.

15-17. *Productella fragilis* n. sp. ---------- 192

Lateral, posterior and pedicle views of a nearly perfect specimen of normal size showing the widely separated spine bases and weak growth wrinkles. (130 C.H.B.) x 1.

PLATE XV

1— 6. *Hypothyridina magister* n. sp. ---------- 198

1— 4. Pedicle, anterior, brachial and lateral views of a specimen of normal size. (935 C.H.B.) x 1.

5— 6. Lateral and anterior views of a rather large specimen. (1255 C.H.B.) x 1.

7—17. *Eatonia gregaria* n. sp. ---------- 196

7— 9. Brachial, pedicle and anterior views of the holotype. (1323 C.H.B.) x 1.

10—12. Similar views of a smaller specimen with four plications on the fold. (1322 C.H.B.) x 1.

13—17. Posterior, anterior, pedicle and brachial views of a small specimen with but two plications on the fold. (1193 C.H.B.) x 1.

18-26. *Camarophoria paupera* Belanski ---------- 193

18—21. Brachial, anterior, pedicle and lateral views of a rather large specimen. (20 C.H.B.) x 2.

22—26. Brachial, posterior, anterior, lateral and pedicle views of a nearly perfect specimen of normal size. (10 C.H.B. x 2.

PLATE XVI

1—10. *Platyrachella ballardi* n. sp ---------- 204

1— 5. Pedicle, brachial, posterior, anterior and lateral views of a specimen of normal size. (277 C.H.B.) x 1.

FIGURES PAGE

6— 7. Posterior and anterior views of a slightly crushed specimen. (1042 C.H.B.) x 1.

8. A portion of the surface of the holotype enlarged to show the granulose stria, x5.

9. Interior of a rather large brachial valve. (262-A C.H.B.) x 1.

10. Cardinal area of a normal specimen enlarged to show the deltidial plate. (702 C.H.B.) x 3.

11—18. *Trigonotreta shellrockensis* n. sp. ---------- 202

11—14. Pedicle, anterior, posterior and lateral views of a specimen of normal size. (720 C.H.B.) x 1.

15—18. Anterior, posterior, lateral and pedicle views of a paratype. (1799 C.H.B.) x 1.

19—22. *Trigonotreta aperturatus* (Schlotheim) ----------
Anterior, posterior, brachial and lateral views of a rather small specimen from the Lower Devonian, Coblenz, Germany, Introduced for comparison with Figs. 11-18. (24740 W.M.) x 1.

23—30. *Spirifer cardinalis* n. sp. ---------- 201

23—26. Posterior, pedicle, brachial and anterior views of a rather large specimen. (315 C.H.B.) x 1.

27—29. Posterior, anterior, and pedicle views of a specimen of normal size. 969 C.H.B.) x1.

30. Pedicle view of a small specimen with a distinct fold in the sinus. (370 C.H.B.) x 1.

PLATE XVII

1— 8. *Platyrachella ulsterensis* n. sp. ---------- 206

1— 3. Posterior, pedicle and anterior views of a large specimen. (1905 C.H.B.) x 1.

4. Cardinal area of the same enlarged to show the deltidial plate. x 3.

5. Pedicle view of a crushed specimen showing the numerous growth wrinkles. (647 C.H.B.) x 1.

6. Portion of the surface of the specimen shown in figure 5 enlarged to show the surface markings. x 5.

7— 8. Pedicle and brachial views of an internal cast which illustrates the size and condition of most of the specimens.. Note low median septum of the pedicle valve. (499 C.H.B.) x 1.

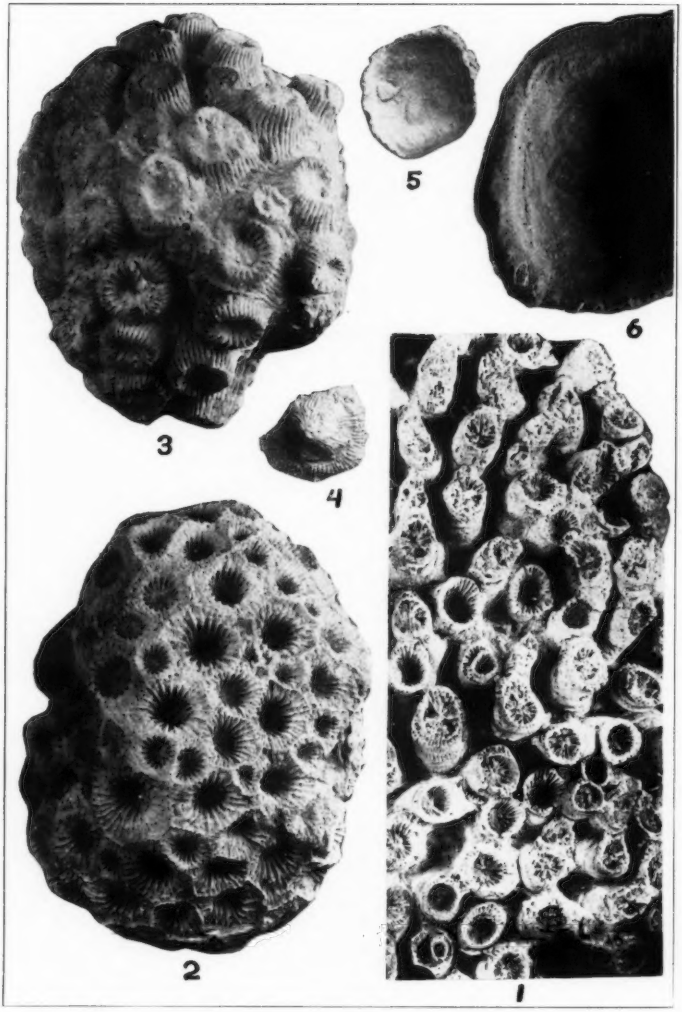

Plate XII

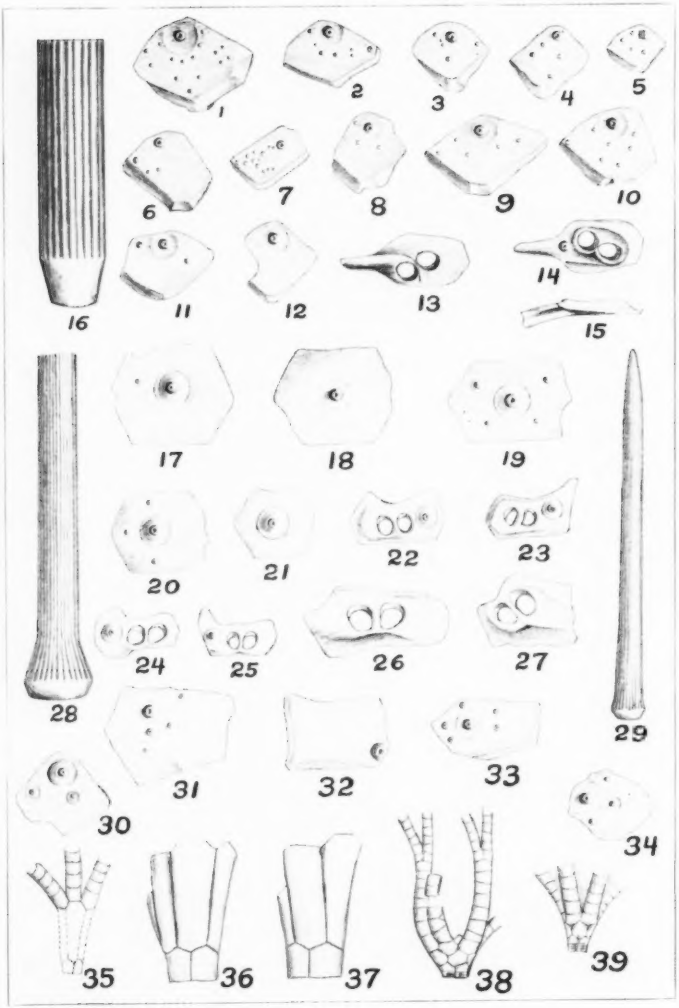
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Plate XIII

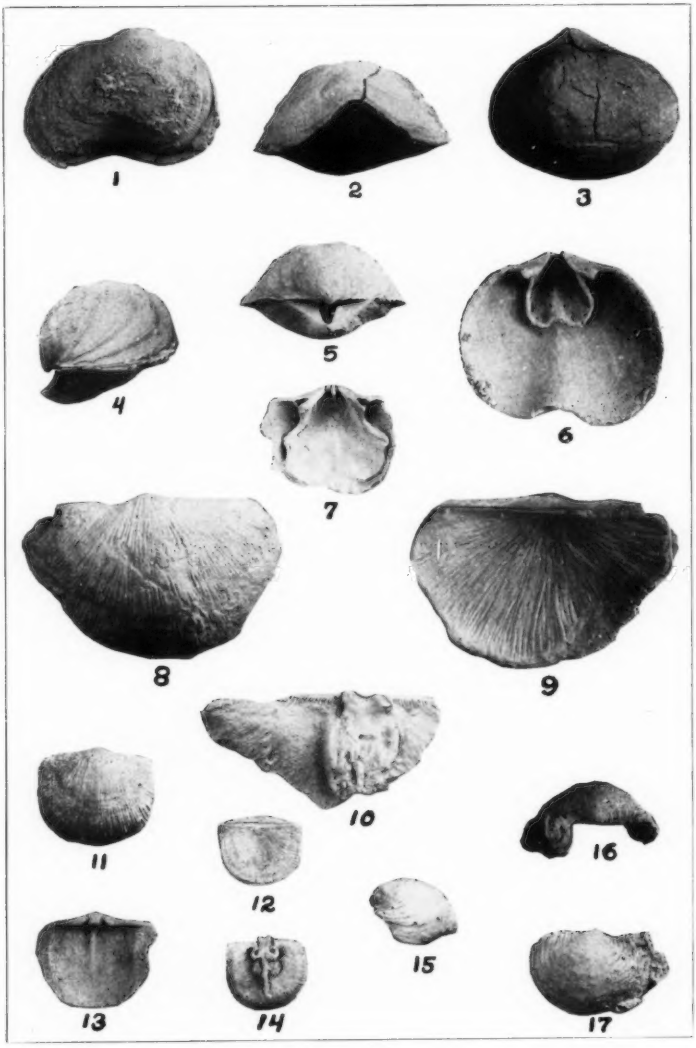

Plate XIV

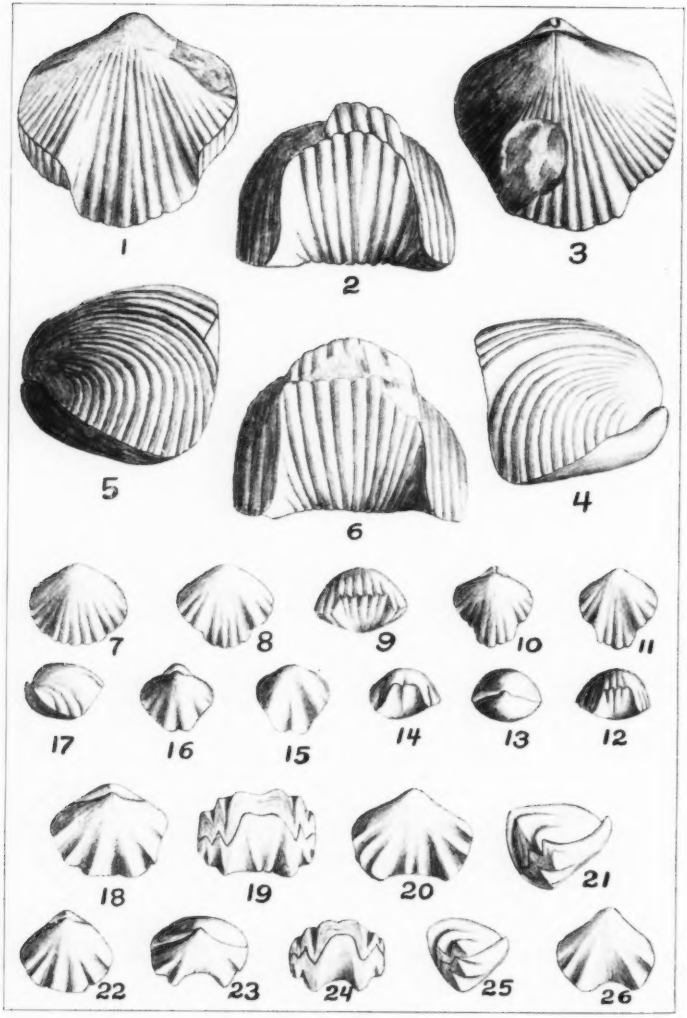

Plate XV

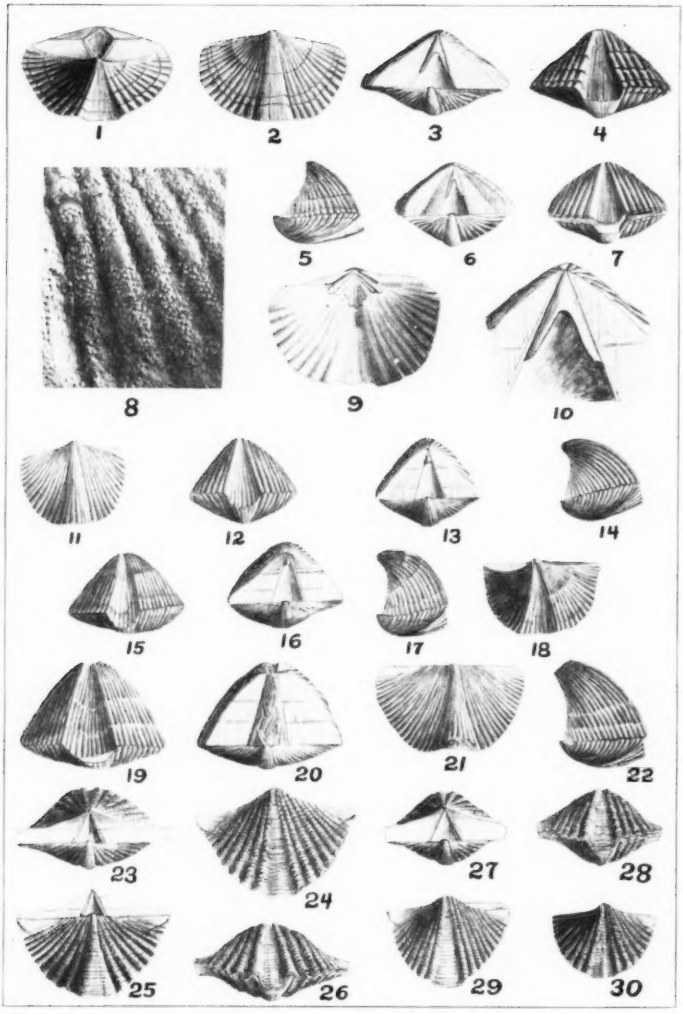
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Plate XVI

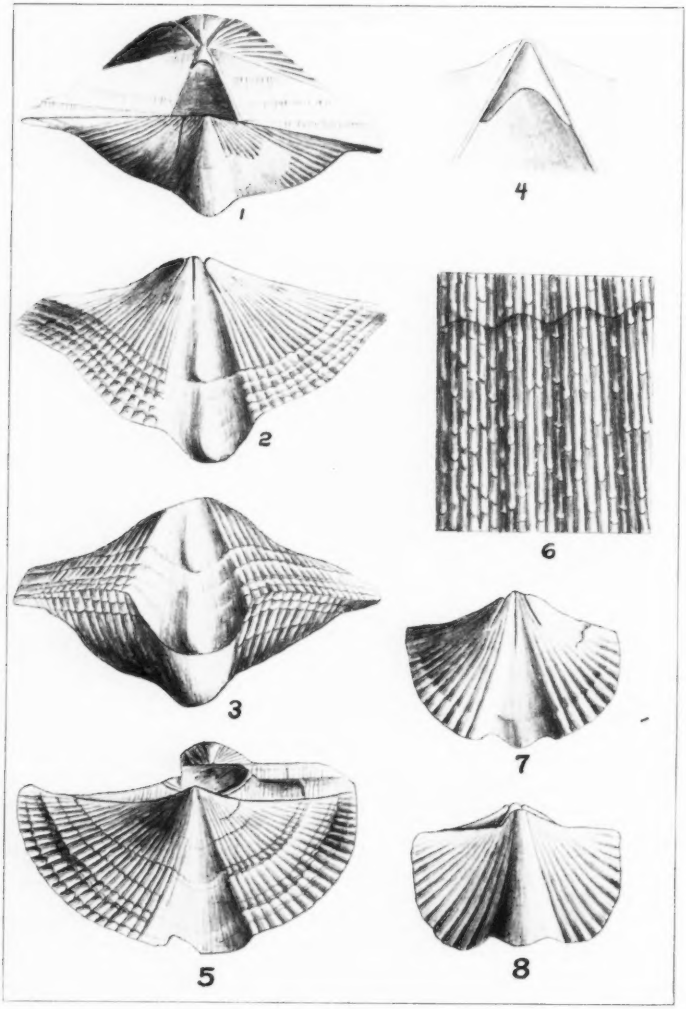

Plate XVII

SOME SPECIES OF SAXIFRAGA

BENJAMIN FRANKLIN BUSH

While looking through a package of unnamed specimens collected by Mr. Palmer in various places in Southern Missouri and Arkansas, I was somewhat surprised to find several collections of SAXIFRAGA, all of which appeared to be the same species, and one that I could not, after a thorough examination, refer to any described species with the aid of the references I had access to at the time.

In order to better inform myself as to the species of SAXIFRAGA likely to be found in Southern Missouri and Arkansas, I procured a copy of Dr. Johnson's Revision of the North American Species of the Section BORAPHILA of SAXIFRAGA, and an examination of this work has been very interesting.

The structural part of this revision, so far as I am able to judge, seems to be excellent, but the systematic part, that part dealing with the species themselves, their relationship and ranges, has the appearance of being the work of another person, in that it shows evidence of carelessness, many discrepancies, and a seeming lack of recognition of specific characters, which is not in agreement with the structural part.

In this Revision Johnson has described a number of new species, of which the northern and western may be quite valid, but those of the eastern and middle States appear to me not to be well founded, particularly those in the *pennsylvanica* group, to which reference more fully will be made further on in this paper.

Taking this Revision of Johnson's as it reads, one would think that the genus SAXIFRAGA was not at all, or but poorly represented in the middle and southern States, that is in Ohio, West Virginia, Indiana, Southern Illinois, Southern Missouri, Arkansas, Western Kentucky, Western Tennessee, Mississippi,

Georgia, Alabama, Louisiana, Oklahoma and Texas. Of this great region, Johnson does not cite a single species for Indiana, Southern Illinois, Western Kentucky, Western Tennessee, Georgia, Alabama, Arkansas, Oklahoma or Louisiana, and only cites one species each for Ohio, Southern Missouri and Texas, and two species for West Virginia.

This neglect of citing the complete range of the species by Johnson, when he had the specimens in hand for study at the time, can only be ascribed to carelessness, for he had all the SAXIFRAGA material from the Missouri Botanical Garden Herbarium, in which I am told there are a lot of specimens collected in Arkansas; and he had all the Deam's collection of SAXIFRAGA for study, more than fifty sheets, collected in Indiana, several from Ohio and Southern Illinois.

There are quite a number of trifling errors in the systematic portion of this Revision of Johnson's that could have been avoided, which mar the appearance of an otherwise admirable piece of work, such as misspellings, wrong dates, incorrect citations, as G. P. Ashcroft for G. B. Ashcroft, G. E. Fisher for G. L. Fisher, Munson, Indiana for Munson, Ohio, Nonquit, Massachusetts for Nonquitt, Massachusetts, Isle Royal for Isle Royale, rocky slopes of Pelican Lake, for rocky shores of Pelican Lake, June 13, 1893, for June 13, 1892, page 51, Sp. Pl. 399, 1752, for L. Sp. Pl. 399, 1753 and others.

To Chas. C. Deam, of Bluffton, Indiana, who has loaned me all of his material for study as well as a number of books on SAXIFRAGA, to Dr. C. O. Rosendahl, of the University of Minnesota, Dr. L. H. Pammel of the Iowa State College, Dr. H. Shantz, of the University of Illinois, Dr. P. C. Standley of the United States National Museum, Dr. W. J. Robbins, of the Missouri State University and Mr. E. J. Palmer, collector for Arnold Arboretum, I am under obligation for the loan of material to study, for all of which I now return thanks.

I am tolerably certain that I have evidences of some five or six species of SAXIFRAGA in Arkansas, Oklahoma and Louisiana, two or three of which are unique in appearance, but will defer publishing these until I can secure more material

for study and learn more about their ranges, but I am proposing one new species, which from an examination of a number of collections, appears to me to merit this distinction.

1. SAXIFRAGA VIRGINIENSIS Michx., Fl. Bor. Am. *1*: 269. 1803.

   S. vernalis Willd. Hort. Berol. 43. 1805.

   S. virginica Nutt. Gen. *1*: 285. 1818.

   S. verna Nutt.

   Dermasea pilosa b. *verna* Haw. Saxifr. 9. 1821.

   S. verna Hort. ex Steudel, Nomen. Bot. ed. 2, II, 524. 1841, according to Haworth, l. c. 9. 1821, but probably to be referred to *S. pilosa*.

   S. virginicnsis Mich. Fl. Bor. Am.*1*: 1803, according to Haworth, l. c. 9. 1821.

   S. vernalis Sternberg, Rev. 8. 1910, according to Haworth, l. c. 9. 1821.

   S. vernalis Sternberg, Rev. 8. 1910.

   Micranthes virginiensis (Michx.) Small, Fl. S.E.U.S. 501. 1903.

Under *Dermasea pilosa*, b *verna*, Haworth says "foliis cuneato-ovalibus argute serratis petiolo brevioribus, caule paniculato, floribus subglomeratis," which agrees quite well with the eastern plant that I take to be Michaux's *Saxifraga virginiensis*.

New Brunswick to Minnesota, Georgia and Tennessee, according to Britton in Manual, l. c. 479, but the Georgia and Tennessee references may refer to the form that I take to be *S. pilosa* Haworth.

New Brunswick to Minnesota, Georgia and Tennessee, Britton & Brown in Illustrated Flora, l. c. 218, being the same statement as that of Britton's Manual.

New Brunswick and Quebec to Minnesota, Missouri and Tennessee, Robinson and Fernald in Manual, l. c. 446, but the Missouri and Tennessee references must apply to *S. pilosa* Haw.

New Brunswick and Minnesota, Georgia and Tennessee. Small in Flora, l. c. 503, being the same statement as that in Britton's Manual.

New Brunswick to Minnesota, Georgia and Tennessee. Small in North American Flora, l. c. 141, being a repetition of the range as given in Britton's Manual.

New Brunswick to Quebec, Minnesota and Missouri, Johnson in Revision, l. c. 33, but the Missouri reference must apply to *S. pilosa* Haworth.

New Brunswick to Minnesota and Virginia, and probably extending further, but the exact distribution not known now.

Silica, Missouri, Bush, l. c. 139, based on specimens collected by Eggert, Russell and Trelease, but these are almost certainly *S. pilosa* Haworth.

Saint Louis, Eggert, l. c. 14, but the specimens were collected in Jefferson County, Missouri, without doubt and are very likely what I take to be *S. pilosa* Haworth.

Plants 2:5 to 3 dm. tall, with more than one-half of the stems consisting of the widely branched inflorescence, usually with several or many flowering branches from the base of the plants; petals thrice the length of the sepals, oblong-spatulate, acute, pure white; sepals broadly lanceolate, acute; follicles recurved at the upper ends and widely spreading. May.

A very variable species, presenting several distinct-looking forms, some of which may be worthy of specific rank when studied more.

Haworth (6) has described several species and varieties under the generic name *Dermasea*, of which *D. pilosa* and *D. elongata* seem to me to be the same, and represent a good distinct species.

There are two very different-looking plants among the specimens examined by me, which may or may not be the same species; the first has the flowers racemosely arranged, and this form I take to be Haworth's *S. pilosa;* the other has the flowers cymosely arranged, the two forms looking quite different in fruit, but otherwise appearing superficially alike; this latter form I take to be the true *S. virginiensis* of Michaux.

Johnson (7) does not cite any collection of *virginiensis* from West or South of Pennsylvania, or West or South of Michigan, being seemingly inclined to regard the western and southern plants as different from *virginiensis*, in which opinion I am inclined to concur.

SPECIMENS EXAMINED: MAINE: Orono, *F. B. Briggs*, May, 1893, U.M. Herb.; Orono, *M. L. Fernald*, May 23, 1888, U.M. Herb. NEW HAMPSHIRE; Hanover, *C. H. Hitchcock*, May 5, 1883, U.M. Herb.; Hanover, *C. H. Hitchcock*, May 5, 1883, U.M. Herb. VERMONT: Rutland, *W. W. Eggleston*, April 27, May 8 and June 3, 1898, three collections on one sheet, U.I. Herb. MASSACHUSETTS: Nobscot Mill, *H. H. Bartlett* 141, May 28, 1905, D. Herb.; Lexington, *M. A. Day* and *M. L. Fernald* 91, May 8, 1902, D. Herb.; Arlington Heights, *F. P. Daniels*, May 1898, U. Mo. Herb.; Arlington, *Noland* and *L. H. Pammel*, May, 1886, I.S.C. Herb. 14016; Cambridge, *B. Fink*, May 6, 1895, I.S.C. Herb. 31441; Lexington, *M. A. Day* and *M. L. Fernald* 91, May 8, 1902, I.S.C. Herb. 22663; Medford *W. H. Manning* 849, May 30, 1880, U.M. Herb.; Beverly, *Sara M. Manning*, May 22, 1882, U.M. Herb.; Nonquitt, *E. P.*, May 1, 1889, U.M. Herb.; Lexington, *M. A. Day*, and *M. L. Fernald* 91, May 8, 1902, U.M. Herb.; Lexington, *M. A. Day* and *M. L. Fernald* 91, May 8, 1902, U.I. Herb.; Lexington, *M. A. Day* and *M. L. Fernald* 91, May 8, 1902, D. Herb.; Amherst, *E. L. Morris*, May 1889, U.M. Herb.; Amherst, *E. L. Morris*, May 1890, U.I. Herb.; Mount Warner, *G. C. Woolson*, April, 1870, U.I. Herb.; Stoughton, *S. F. Blake*, May, 1909, U.I. Herb.; Framingham, *H. H. Bartlett* 141, May 28, 1905, D. Herb. CONNECTICUT: Locality, collector and date not given, U.S.N. Herb. 777177. NEW YORK: Brooklyn, *Louisa M. Stables*, April 30, 1885, I.S.C. Herb. 76209; Ithaca, *W. C. Muenscher* and *A. R. Bechtel* 193, May 9, 1920, I.S.C. Herb. 112536; Ithaca, *H. E. Summers*, month and year not given, I.S.C. Herb. 74876; Ithaca, *H. E. Summers*, April 30, year not given, I.S.C. Herb. 74878; Ithaca, *H. E. Summers*, May 6, 1887, I.S.C. Herb. 74877; Ithaca, *H. E. Summers*, May 10, 1883, I.S.C. Herb. 73569; Ithaca, *E. J. Durand*, April 23, 1891,

U.M. Herb.; New Castle, collector not given, April 30, 1885, I.S.C. Herb.; East Greenwich, *A. Fitch*, month not given, 1861, U.M. Herb.; Troy, *R. H. Ward*, month not given, 1864, U.I. Herb.; Chestnut Hill, collector not given, May 2, 1891, U.I. Herb.; Canadian Lake, *E. J. Hill*, May 29, 1895, U.I. Herb.; Prince's Bay, Staten Island, *G. S. Hulst*, April 29, 1891, U.I. Herb., locality not given; *Hariting*, April 28, 1919, U.I. Herb.; locality, collector and date not given, U.I. Herb. NEW JERSEY: Woodbridge, *L. H. Lighthipe*, May, 1895, U.M. Herb.; Trenton, collector not given, April, 1888, U.I. Herb. DISTRICT OF COLUMBIA: Washington, *E. S. Steele*, April 11, 1897, U.M. Herb. MARYLAND: Hagerstown, *F. B. Trask*, April, 1925, I.S.C. Herb. 117762; Glen Echo, *L. H. Dewey*, 177, April 6, 1895, I.S.C. Herb. 48657; High Island, *E. L. Morris*, April, 1897, U.M. Herb. PENNSYLVANIA: Safe Harbor, *A. A. Heller* and *E. G. Halbach* 804, April 29, 1893, U.M. Herb.; Wissahickon, *J. B. Brinton*, May 13, 1883, I.S.C. Herb. 40060; Rawlinsville, *J. Galen*, date not given, U.M. Herb.; Lancaster, *J. K. Small*, April 12, 1889, U.M. Herb.; Allegheny County, *A. Koenig*, April 28, 1892, U.M. Herb.; Sayre *W. C. Barbour* 25, April 23, 1898, U.I. Herb. VIRGINIA: Rosslyn, *D. L. Topping*, April 13, 1895, U.M. Herb.; Rosslyn, *A. Chase* 2125, April 12, 1904, U.I. Herb.; Rosslyn, *A. Chase* 2125, April 12, 1904, U.I. Herb. ALABAMA: Locality, collector and date not given. U.I. Herb. CANADA: Cap a la Branche, Quebec, *M. Victorin* 4174, June, 1917, D. Herb.; Sparta, Ontario, *G. L. Fisher*, May 14, 1899, U.M. Herb.; Cap a la Branche, Quebec, *M. Victorin*, 4174, June 1917, D. Herb. MICHIGAN: Williamstown, *R. H. Ward*, July, 1856, U. I. Herb.; Isle Royale, Tobin's Harbor, *W. R. Wheeler* 716 and 722, August, 1900, U.M. Herb. OHIO: Newark, *Williamson*, April 19, 1897, D. Herb.; Lancaster, *A. Bigelow*, date not given, I.S.C. Herb. 14017; Hinckley, *J. R. Watson*, May, 1895, U.M. Herb.; Hinckley, *J. R. Watson*, June 1, 1894, U.M. Herb.; Akron, *K. O. Foltz*, April 22, 1888, U.M. Herb.; Newark, *E. B. Williamson*, April 18, 1897, D. Herb. INDIANA: Cannelton, *Deam* 27799, April 24, 1919, D. Herb.; Rockport, *Deam* 5534,

March 28, 1910, D. Herb; Cannelton, *Deam* 19362, May 5, 1916, D. Herb.; Spencer County, *Deam* 5534, March 28, 1910, D. Herb. MINNESOTA: Pelican Lake, *C. O. Rosendahl* 2381, August 30, 1909, U.M. Herb.; Two Harbors, *J. H. Sandberg*, May, 1891, U.M. Herb.; Two Harbors, *E. P. Sheldon*, June, 1893, U.M. Herb.; Flag Island, Lake of the Woods, *C. Mac Millan* and *E. P. Sheldon*, June, 1893, U.M. Herb. KENTUCKY: Dawson Springs, *E. J. Palmer* 22549, May 7, 1923, P. Herb.; Louisville, *O. E. Mueller*, April, year not given, U.M. Herb. TENNESSEE: Clarksville, *T. L. Andrews* 130, month not given, 1846, I.S.C. Herb. 32945; Lookout Mountain, *J. Schneck*, May 11, 1901, U.I. Herb. GEORGIA: Stone Mountain, *Biltmore Herb.* 204C, April 15, 1897, U.M. Herb. NO STATE GIVEN: No locality given, but probably Minnesota. *T. L. Andrews* 78, date not given, I.S.C. Herb. 81553.

A small part of the above cited specimens, especially the western and southern specimens, are probably to be referred to *S. pilosa*, but I have now no longer the opportunity to correct the determinations, the specimens having passed out of my hands before I concluded that the southern plant was *S. pilosa*.

2. SAXIFRAGA PILOSA Haworth, Saxifr. Enum. 8. 1821

S. virginiensis Pursh, Fl. Am. Sept. 310. 1814. not *S. virginiensis* Michaux, 1803.

Dermasea pilosa Haworth, Saxifr. 8. 1821.

Dermasea elongata Haworth, Saxifr. 9. 1821.

S. pilosa Banks; D. Don. frans. Linn Soc. *13*: 386. 1822, as synonym.

S. verna Hort. ex Steudel, Nomen. Bot. ed. 2. II, 524, as synonym of *Dermasea elongata* Haworth.

Of this form Haworth (5) says "Folia obovata obtusissima dentata, basi saepe subcuneata, utrinque pilis brevibus erectus vestita, petiolis folia longioribus semi-teretiusculis. Pedunculi solitarii brevis, pilis horizontalibus minute vestiti, Facies sequentis, at paulo major, minute omnino pilosa (fructificatione excepta)." This clearly describes the western

and southern plants and appears to me to indicate a good species.

If these Saxifrages should be referred to the genus MICRANTHES, this species may properly be named MICRANTHES PILOSA (*Haw.*) n. comb.

SPECIMENS EXAMINED: MISSONRI: Jefferson County, *Eggert*, April 14, 1887, U.S.N.M. Herb. 518716; Mine La Motte, *E. J. Palmer* 30285, May 22, 1926, P. Herb.; Mine La Motte, *E. J. Palmer* 30285, May 22, 1926, P. Herb.; Jefferson County, *Eggert*, May 20, 1887, U. Mo. Herb. INDIANA: Fredonia, *Deam*, 44075, April 24, 1927, D. Herb.; Tobinsport, *Deam* 44182, May 4, 1927, D. Herb. KENTUCKY: Dawson Springs, *E. J. Palmer* 22549, May 7, 1923, P. Herb.; Louisville, *C. Mohr*, May 6, 1855, U.S.N.M. Herb. 772177, three plants on this sheet, the one marked 2. TENNESSEE: Madison County, *S. M. Bain*, April, 1822, U.S.N.M. Herb. 215157; Nashville, *A. Gattinger*, date not given, U.S.N.M. Herb. 777177; Erin, *E. J. Palmer* 17605, May 24, 1920, P. Herb.

3. SAXIFRAGA PALMERI n. sp.

Differing from *S. virginiensis* in being only 1.5 to 2.5 dm. tall; in having smaller, differently-shaped leaves, which are rounder at the base and entire or very obscurely sinuately-denticulate on the margins; in having an earlier flowering period; in having fewer flowering branches which are more strict, ascending or erect; fewer or usually no flowering branches from the base of the plants; branches of the inflorescerd consisting of less than one-half the height of the plant; petals broadly oblong, spatulate, broad and rounded at the obtuse ends, and green-lined at the broad scarious tips; follicles but little recurved, the beaks nearly erect or but little spreading. April.

This very distinct species of *Saxifraga* occurs in the mountainous regions about Van Buren, in western Arkansas (and the adjacent portions of Eastern Oklahoma) which is far from the known range of *S. virginiensis*, and somewhat removed from *S. pilosa* which has been collected in Kentucky,

Tennessee and in a few localities in extreme eastern Missouri.

For those who prefer the name MICRANTHES for these Saxifrages, I offer the name MICRANTHES PALMERI n. sp., for this plant.

Johnson (7) in his Revision does not cite any species of *Saxifraga* for Arkansas, but I have seen *S. pilosa* from about Pine Bluff, *S. Texana* from many localities in western Arkansas, and several other species that I have not yet determined.

SPECIMENS EXAMINED: ARKANSAS: Van Buren, *E. J. Palmer* 20731, April 10, 1922, P. Herb.; Van Buren, *E. J. Palmer* 29710, April 19, 1926, P. Herb.; Van Buren, *E. J. Palmer*, April 29, 1922, P. Herb.; Van Buren, *E. J. Palmer* 21020, April 30, 1922, P. Herb., all included in the TYPE; Jasper, Newton County, *E. J. Palmer* 27089, May 8, 1925, P. Herb.; Magazine Mountain, *E. J. Palmer* 24844, May 12, 1924, P. Herb.; Cove Creek Station, *E. J. Palmer* 29170, April 19, 1926, P. Herb.; Magazine Mountain, *E. J. Palmer* 24855a, May 12, 1924, P. Herb.; Magazine Mountain, *E. J. Palmer* 26932, April 26, P. Herb.

4. SAXIFRAGA MICRANTHIDIFOLIA (Haw.) B.S.P. Prel. Cat. N. Y. 17. 1888.

Robertsonia micranthidifolia Haw. Syn. Pl. Succ. 322. 1812.

Saxifraga erosa Pursh, Fl. Am. Sept. 311. 1814.

Saxifraga micranthifolia Steud. Nom. Bot. 736, 1821.

Aulaxis micranthifolia Haw. Saxifr. Enum. 47. 1821.

Saxifraga Wolleana T. & G. Fl. N. Am. *1*: 569. 1840.

Micranthes micranthidifolia (Haw.) Small, Fl. S.E. U.S. 501. 1903.

Pennsylvania to North Carolina, Britton in Manual, l. c. 479.

Pennsylvania to North Carolina and Tennessee, Robinson and Fernald in Manual, l. c. 446.

Pennsylvania to North Carolina and Tennessee, Small in Flora, l. c. 143.

Pennsylvania to North Carolina, Britton & Brown in Illustrated Flora, l. c. 219.

Pennsylvania to Georgia and Tennessee, Small in North American Flora, l. c. 143.

New Jersey to North Carolina, Tennessee and West Virginia, Johnson, l. c. 19.

SPECIMENS EXAMINED: TENNESSEE: Wolf Creek, *A. Ruth* 269, July, 1898, U.S.N.M. Herb. 345443; Roan Mountain, *Bitt. Herb.* 886c, July 15, 1903, U.S.N.M. Herb. 959296; Eastern Tennessee, *C. C. Parry*, month not given, 1870, U.S.N.M. Herb. 44118.

5. SAXIFRAGA TENNESSEENSIS Small, Bull. Torr. Club *23*: 364. 1896.

Micranthes tennesseensis Small, Flora S.E.U.S. 501. 1903.

Tennessee, Small in Flora, l. c. 503.

Tennessee and North Carolina, Johnson in Revision l. c. 32.

Tennessee, Small in North American Flora, l. c. 142.

SPECIMENS EXAMINED: TENNESSEE: Knox County, *A. Ruth* 982, April 20, 1897, I.S.C. Herb.; Knoxville, *A. Ruth*, June, 1896, U. I. Herb.; Knoxville, *A. Ruth*, May 10, 1901, U.I. Herb.; Knoxville, *A. Ruth*, April, 1895, U.M. Herb.; Knoxville, *A. Ruth*, April, 1894, U.M. Herb.; Knoxville, *A. Ruth*, April and May, 1897, two collections on one sheet, U.M. Herb.; Knoxville, *A. Ruth*, April, 1895, U.S.N.M. Herb. 286476; Knoxville, *A. Ruth*, June, 1900, U.S.N.M. Herb. 391709; Knoxville, *A. Ruth*, May and June, 1895, U.S.N.M. Herb. 772174; Knoxville, *A. Ruth*, April and May, 1897, U.S.N.M. Herb. 313042; Knoxville, *A. Ruth*, May, 1898, U.S.N.M. Herb. 345444; Knoxville, *A. Ruth*, April, 1897, U.S.N.M. Herb. 958401; Knoxville, *A. Ruth*, April, 1895, U.S.N.M. Herb. 772175; Knoxville, *S. M. Bain*, April, 1894, U.S.N.M. Herb. 263003; Knoxville, *S. M. Bain*, April, 1894, U.S.N.M. Herb. 263004; Knoxville, *Bilt. Herb.* 1204c, May 1, 1903, U.S.N.M.

Herb. 958442. NORTH CAROLINA: Cedar Cliff Mountain, *Bilt. Herb.*, May 11, 1897, U.M. Herb.

6. SAXIFRAGA CAROLINIANA A. Gray Mem. Am. Acad. II, *3*: 39, 1846.

S. Grayana Britton, Mem. Torr. Club *5*: 178. 1894.

Micranthes Grayana (Britton) Small, Fl. S.E.U.S. 501. 1903.

Micranthes Caroliniana (A. Gray) Small, N. A. Flora *22*: pt. 2, 146. 1905.

Virginia and North Carolina, Britton in Manual, l. c. 480.

Virginia, Robinson and Fernald in Manual, l. c. 446.

Virginia and North Carolina, Small in Flora, 504. 1903.

Virginia and North Carolina, Britton & Brown in Illustrated Flora, l. c. 219.

Virginia, West Virginia and North Carolina, Johnson in Revision, l. c. 25.

SPECIMENS EXAMINED: VIRGINIA: Chatham Hill Gap, *J. K. Small*, June 13, 1892, U.M. Herb.

7. SAXAFRAGA CAREYANA A Gray, Lond. Journ. Bot. *2*: 116. 1843.

Micranthes Careyana (A. Gray) Small, Fl. S.E.U.S. 503. 1903.

North Carolina and Tennessee, Small in Flora, l. c. 503.

North Carolina, Johnson in Revision, l. c. 23.

North Carolina, Small in N. A. Fl. 142.

SPECIMENS EXAMINED: NORTH CAROLINA: Roan Mountain, *J. W. Chickering, Jr.*, July 5, 1880, U.M. Herb.

8. SAXIFRAGA TEXANA Buckley, Proc. Phila. Acad. 18661: 455. 1862.

Micranthes texana (Buckley) Small, Fl. S.E.U.S. 501. 1903.

Missouri and Texas, Britton & Brown in Illustrated Flora, l. c. 218.

Missouri and Texas, Bush, l. c. 140.

Missouri and Texas, Johnson in Revision, l. c. 55.
Texas and Missouri, Small in Flora, l. c. 503.
Arkansas and Texas, Small in North American Flora, l. c. 137.

A calciphile species inhabiting the limestone barrens of Southern Missouri, especially the Grand Falls Chert barrens, southeastern Kansas, Western Arkansas, Western Louisiana and Eastern Texas.

SPECIMENS EXAMINED: MISSOURI: Reding's Mill, *Bush* 5475, April 8, 1909, U.S.N.M. Herb. 671856; Reding's Mill, *Bush*, 5475, April 8, 1909, U.S.N.M. Herb. 648013; Reding's Mill, *E. J. Palmer* 1647, April 8, 1909, U.I. Herb.; Reding's Mill, *E. J. Palmer*, 19607, March 19, 1921, P. Herb.; Alba, *E. J. Palmer*, 17148, April 7, 1920, P. Herb. TEXAS: Brazos County, *H. Ness*, March 10, 1900, U.S.N.M. Herb. 386993; Hockley, *F. W. Thurow*, month not given, 1889, U.S.N.M. Herb. 44120; Limestone County, *J. F. Joor*, Spring, 1878, U.S.N.M. Herb. 44121; Groesbeck, Limestone County, *J. F. Joor*, 87, February 27, 1887, a place where Joor lived for several years.

Bush (3) cites "Groesbeck, *Joor*, 87, February 27, 1887," Johnson (7) cites "no State cited, February 27, 1878, J. F. Joor."

Bush (3) cites "between French Town and Dallas, *J. Reverchon*, 287."

Johnson (7) cites "between French Town and Dallas, *J. Reverchon*, 281."

9. SAXIFRAGA PETIOLARIS (Raf.) n. comb.

Hexaphoma petiolaris Raf. Fl. Tell. *2*: 67. 1836.

Saxifraga leucanthemifolia Michx. Fl. Bor. Am. *1*: 118. 268, 1803. Not *S. leucanthemifolia* La Peyr. 1803.

Saxifraga Michauxii Britton, Mem. Torr. Club *4*: 118. 1894.

Spatularia leucanthemifolia (Michx.) Haus. Saxifr. Enum. 48. 1821.

Spataluria Michauxii (Britton) Small, Fl. S.E.U.S. 502. 1903.

Spatularia petiolaris (Raf.) Small, N. Am. Fl. *22*: part 2, 150. 1905.

Hydatica petiolaris (Raf.) Small, Fl. S.E.U.S. 760. 1911.

Virginia and W. Virginia to Georgia, Britton in Manual, l. c. 480.

Virginia and North Carolina to Georgia, Robinson and Fernald in Manual, l. c. 446.

Virginia and Georgia to Tennessee, Small in Flora, l. c. 504.

Virginia to Georgia, Britton & Brown in Illustrated Flora, l. c. 221.

Virginia to Georgia, Small in North American Flora, l. c. 130.

Maryland, Virginia, Tennessee, North Carolina and Georgia, Johnson in Revision, l. c. 65.

A species of the mountainous regions of Virginia, North Carolina, Tennessee and Georgia. For those who prefer the name *Micranthes* as the generic name of these Saxifrages, I offer the name *Micranthes petiolaris* (Raf.) n. comb., for this species.

SPECIMENS EXAMINED: TENNESSEE: Roan Mountain, *Bilt. Herb.* 1231g, July 14, 1903, U.S.N.M. Herb. 959292; Roan Mountain, *R. Thaxter*, August 8, 1887, U.S.N.M. 415915; Roan Mountain, *A. S. Hitchcock*, July 27, 1905, U.I. Herb.; Mount Leconte, *Nile* 351, August, 1924, U.I. Herb.; Mount Leconte, *Kendall* 353, August 1924, U.I. Herb.

10. SAXIFRAGA PENNSYLVANICA L. Sp. Pl. 1753.

S. pennsylvanica minor D. Don, Trans. Linn. Soc. *13*: 384. 1852.

Micranthes pennsylvanica (L.) Haw. Saxifr. Enum. 45. 1821.

Maine to Ontario, Minnesota, Virginia, Iowa and Missouri, Britton in Manual, l. c. 479.

New England to Virginia, West to Minnesota and Missouri, Robinson and Fernald in Manual, l. c. 446.

Maine to Ontario, Minnesota, Virginia, Iowa and Missouri, Britton & Brown in Illustrated Flora, l. c. 219.

Maine and Ontario, to Minnesota, Virginia and Missouri, Small in North American Flora, l. c. 139.

A paludicole species of the Eastern States, usually found in swamps and wet meadows, low wet swales on the prairies and similar situations, extremely variable and therefore presenting many more or less marked forms or individuals, some of which have been taken up by Johnson (7) for species, and these I will take into consideration further on in this paper.

SPECIMENS EXAMINED: NEW HAMPSHIRE: Hanover, *C. H. Hitchcock*, June 9, 1883, U.M. Herb. MASSACHUSETTS: Hadley, *G. C. Woolson*, May, 1870, U.I. Herb.; Somerville, *W. H. Manning*, 852, May 26, 1879, U.M. Herb. NEW JERSEY: Birmingham, *H. M. Willmarth*, May, 1883, U.I. Herb.; Eagle Rock, *K. K. Mackenzie*, 129, May 17, 1903, D. Herb.; Passaic, *E. W. Berry*, May 30, 1895, U.I. Herb. NEW YORK: McLean, *E. J. Durand*, May 23, 1891, U.M. Herb. PENNSYLVANIA: Penryn, *A. A. Heller*, May 30, 1890, U.M. Herb. OHIO: No locality given, *G. H. French*, no date given, U.S.N.M. Herb. 958396, three plants on this sheet, the ones marked 1 and 3; Georgia Lake, *L. D. Stair*, June 2, 1894, U.S.N.M. Herb. 958404; Mansfield, *E. Wilkinson*, 3178, May 20, 1899, U.S.N.M. Herb. 958492; Oberlin, *C. A. Kofoid*, May 21, 1891, U.S.N.M. Herb. 892351; Oberlin, *A. R. Ricksecker*, May 19, 1894, U.S.N.M. Herb. 217469; Oberlin, *A. E. Ricksecker*, May 29, 1895, U.S.N.M. Herb. 286712; Geauga Lake, *L. D. Stair*, June 2, 1894, U.S.N.M. Herb. 307940; Oberlin, *A. E. Ricksecker*, May 19, 1894, U.S.N.M. Herb. 251241; Richland County, *E. Wilkinson*, 3178, May 20, 1899, U.M. Herb.; Liverpool, *J. R. Watson*, June, 1896, U.M. Herb.; Munson, *J. R. Watson*, June 7, 1897, U.M. Herb.; Munson, *G. B. Ashcroft*, June, 1897, U.M. Herb. MASSACHUSETTS: Monson, *E. L. Morris*, May, 1884, U.S.N.M. Herb. 958396. NEW YORK: Ithaca, *W. W. Resole*,

June 1891, U.S.N.M. Herb. 958493. INDIANA: Clarke, *L. M. Umbach*, June 4, 1898, U.S.N.M. Herb. 339377; Clarke, *L. M. Umbach* 221, May 25, 1895, U. M. Herb; Miller, *R. Kienbolz*, May 26, 1918, U.I. Herb.; Miller, *A. Chase* 1792, May 30, 1902, U.I. Herb.; Thayer, *C. C. Deam*, 40557, June 6, 1924, D. Herb.; Norris Marsh, *C. C. Deam* 30930, June 7, 1920, D. Herb; Kramer, *C. C. Deam* 23034, May 15 1917, D. Herb.; Bluffton, *C. C. Deam* 3049, May 22, 1908, D. Herb.; Springport, *C. C. Deam* 44507, June 13, 1927, D. Herb.; Winchester, *C. C. Deam* 19689, May 16, 1916, D. Herb.; Bluffton, *C. C. Deam*, May 16, 1897, D. Herb.; Porter, *C. C. Deam* 20045, June 3, 1916, D. Herb.; Newberry, *C. C. Deam* 42793, May 19, 1926, D. Herb.; Michigan City, *C. C. Deam* 13051, May 28, 1913, D. Herb.; Ontario, *C. C. Deam* 15731, May 18, 1915, D. Herb.; Leesburg, *C. C. Deam* 30591, June 3, 1920, D. Herb.; Portland, *C. C. Deam* 19743, May 18, 1916, D. Herb.; Fountain, *C. C. Deam* 27327, May 9, 1919, D. Herb.; Harmony, *C. C. Deam* 12622, May 4, 1913, D. Herb. ILLINOIS: Oregon, *M. B. Waite*, June 17, 1885, U.S.N.M. Herb. 491007, two plants on this sheet, the one marked 2; Wady Petra, *V. H. Chase* 1344, May 19, 1907, U.S.N.M. Herb. 645279; Chicago, *W. S. Moffatt*, June 26, 1922, U.M. Herb.; Mount Carmel, *J. Schneck*, May 24, 1877, U.I. Herb.; Wady Petra, *V. H. Chase*, May 12, 1877, U.I. Herb.; Nail Mall, *S. O. Eaton*, date not given, U.I. Herb.; Peoria, *F. Brendel*, date not given, U.I. Herb.; Jo Daviess County, *H. S. Pepoon*, June, year not given, U.I. Herb.; Mascoutah, *W. Welsch*, date not given, U.I. Herb.; Beach, *F. C. Gates* 1675, June 16, 1907, U.I. Herb.; Peoria, *F. Brendel*, date not given, U.I. Herb.; no locality given, *J. Schneck*, date not given, U.I. Herb.; Woodford County, *F. E. McDonald*, June, 1887, U.I. Herb., two collections on this sheet; Shannon's Swamp, *J. Schneck*, April 25, 1882, U.I. Herb. MICHIGAN: Haslets, *T. T. Yuncker* 355, July 2, 1917, U.I. Herb.; Williamstown, *R. H. Ward*, June, 1857, U.I. Herb. MINNESOTA: Lake City, *S. M. Manning*, July 1, 1878, two collections on this sheet, one of which I destinguish as a variety of *pennsylvanica*, further on in this paper, N. M. Herb.;

Saint Paul, *R. Gmelin*, July, 1890, I.S.C. Herb.; Nichols, *E. P. Sheldon* 2305, June 1892, U.M. Herb.; Saint Croix Falls, *F. K. Butters, C. O. Rosendahl* and *A. M. Johnson*, June 5, 1920, U.M. Herb.; Bush Lake, *C. O. Rosendahl* and *F. K. Butters, June* 27, 1919, U.M. Herb.; Lake Johanna, *C. O. Rosendahl* 3808, June 18, 1919, U.M. Herb.; Rochester, *G. G. Ainslie*, May 24, 1902, U. M. Herb.; no locality given, *N. L. V.*, June 15, year not given, U.M. Herb.; Saint Louis County, *E. P. Sheldon* 4946, June 1893, U.M. Herb.; Winona, *J. M. Holzinger*, June 1, 1886, U.M. Herb.; Chaska, *C. A. Bullard*, June, 1891, U.M. Herb.; Milrea, *E. P. Sheldon* 3005, July, 1892, U.M. Herb.; Benedict, *H. J. Bergman* 3109, August 26, 1914, U.M. Herb. MASSACHUSETTS: Belmont, *F. P. Daniels*, June, 1898, U. M. Herb.

10A. SAXIFRAGA PENNSYLVANICA CRASSICARPA (Johnson) n. var.

S. crassicarpa Johnson, Rev. N. A. Sp. of SAXIFRAGA, 43. 1923.

Minnesota, Wisconsin and Illinois, according to Johnson, l. c. 42. 43.

I have studied this form very carefully, and have come to the conclusion that it can not be maintained as a species, if indeed it is anything more than a mere variation of *pennsylvanica*, but I am allowing it to stand as a variety of this species.

SPECIMENS EXAMINED: MINNESOTA: Saint Louis River, *J. C. Arthur, L. H. Bailey, Jr.* and *E. W. D. Holway* B329, July 23, 1886, TYPE of *S. crassicarpa* Johnson, U.M. Herb.; Lake Johanna, *C. O. Rosendahl* 3809, 3810 and 3811, June 18, 1919, N.M. Herb. These three collections are much better examples of what Johnson intended to typify in his *S. crassicarpa*, than are his type-specimens; Lake City, *S. M. Manning*, July 1, 1878, U.M. Herb., two collections on this sheet, one being typical *pennsylvanica;* Snelling Reservation, *C. O. Rosendahl* 2100, June 15, 1909, U.M. Herb., two collections on this sheet, one being what I am distinguishing as a variety

of *pennsylvanica* further on in this paper; Flensburg, *Chandonnet*, June 15, 1910. WISCONSIN: Kilbourne, *L. H. Pammel*, June, 1913, I.S.H. Herb. INDIANA: Lake Everett, *C. C. Deam* 14240, May 31, 1914, D. Herb.; Hamlet, *C. C. Deam* 30881, June 6, 1920, D. Herb.; Medarysville, *C. C. Deam* 40572, June 7, 1924, D. Herb.; Lake Gage, *C. C. Deam*, June 16, 1905, D. Herb.; Idaville, *C. C. Deam* 20166, June 7, 1916, D. Herb.

For those who prefer MICRANTHES as the generic name of these Saxifrages, I offer MICRANTHES PENNSYLVANICA CRASSICARPA (Johnson) n. var., as the name of this plant.

10B. SAXIFRAGA PENNSYLVANICA PURPURIPETALA (Johnson) n. var.

S. purpuripetala Johnson, Rev. N. A. Sp. of SAXIFRAGA, 51. 1923.

Vermont and New Jersey, according to Johnson, l. c. 52. 1923.

SPECIMENS EXAMINED: NEW YORK: North Harpersfield, *D. L. Topping* 72, June 20, 1906, U.M. Herb.; Ithaca, *W. C. Muencher* and *A. R. Bechtel* 192, June 20, 1897, I.S.C. Herb. VERMONT: Rutland, *W. W. Eggleston*, May 16, 1896, U.M. Herb. I have been unable to find any character that would separate this form from typical *pennsylvanica*, and it seems to occur throughout the range of this species. The purple color that Johnson lays so much stress on, seems to me to be only an individual character, and I am therefore reducing Johnson's species to varietal rank, and it really does not appear to me to deserve this. If it should be that the name MICRANTHES is accepted as the generic name of these Saxifrages, I offer MICRANTHES PENNSYLVANICA PURPURIPETALA (Johnson) n. var., as the name of this form.

10c. SAXIFRAGA PENNSYLVANICA WINNEBAGOENSIS (Johnson) n. var.

S. winnebagoensis Johnson, Rev. N. A. Sp. of SAXIFRAGA, 53. 1923.

SPECIMENS EXAMINED: MINNESOTA: Winnebago Valley,

Houston County, *W. A. Wheeler* 180, June 12, 1899, TYPE of Johnson's *S. winnebagoensis*, U.M. Herb.; Deer Creek, *A. M. Johnson, F. K. Butters* and *C. O. Rosendahl* 4086, June 14, 1921, U.M. Herb.

This form appears to me to be only a slight variation of *pennsylvanica* having smaller follicles than usual, and as many collections have been made along the Winnebago Valley without revealing any other specimens that agree with Johnson's description I suspect his to be only an individual variation of *pennsylvanica*. If this form is to be recognized as a variety, and the name MICRANTHES is applied to these species, I offer

*M*ICRANTHES PENNSYLVANICA WINNEBAGOENSIS (Johnson) n. var., for this form.

10D. SAXIFRAGA PENNSYLVANICA FULTIOR (Fernald) n. var.
S. pennsylvanica forma *fultior* Fernald, Rhodora *19*: 141. 1917.

SPECIMENS EXAMINED: MASSACHUSETTS: Amherst, *E. L. Morris*, April, 1890, U.M. Herb. PENNSYLVANIA: Penryn, *A. A. Heller* and *E. G. Halbach* 872, May 27, 1893, I.S.C. Herb. ILLINOIS: Wady Petra, *V. H. Chase*, May 12, 1897, U.I. Herb.

Johnson does not give any range for this form, which seems to me to be only an individual variation of *S. pennsylvanica*, which possibly might be perpetuated in cultivation.

If it should prove to be only an occasional form of *S. pennsylvanica*, and be recognized as a form of that species, and the name MICRANTHES is accepted as the generic name of these Saxifrages, I offer MICRANTHES PENNSYLVANICA forma FULTIOR (Fernald) n. comb., for this form.

10E. SAXIFRAGA PENNSYLVANICA HIRSUTA n. var.

Leaves narrowly oblong, 6-10 inches long, 1 to 2 inches wide, obtuse, minutely serrulate all around excepting the broadly margined base, or sometimes entire, densely hirsute on both sides, especially at the broad dilated bases; stems 18 to 36 inches tall, thinly long-pilose below, glandular-pilose

above and near the top, the branches of the inflorescence also glandular-pilose; otherwise much as in typical *pennsylvanica*.

I can not be sure this is anything more than a mere state of *S. pennsylvanica*, although it looks very different from the ordinary state of that species, and it is just as much entitled to specific rank as several species described by Johnson.

In a species so very variable and so widely distributed as *S. pennsylvanica*, there are sure to be more or less different-looking individuals, but that these individuals are entitled to recognition as species, is something I can not favor.

SPECIMENS EXAMINED: MINNESOTA: Money Creek Valley, *C. O. Rosendahl* and *F. K. Butters* 4274, three sheets, June 2, 1922, U.M. Herb., TYPE; Gwinn's Bluff, *C. O. Rosendahl* and *F. K. Butters* 3965, two sheets, July 2, 1920, U.M. Herb.; Saint Croix Falls, *C. O. Rosendahl* and *F. K. Butters*, June 5, 1920, U.M. Herb. MICHIGAN: Hamilton, *C. L. Herron*, May 29, 1891, U.M. Herb. IOWA: Farley, *E. R. McGee*, May, 1893, U.M. Herb. MISSOURI: Jefferson County, *H. Eggert*, May 11, 1887, labaled *S. Forbesii*, but quite different from other specimens collected by Eggert on same date, same locality, also labeled *S. Forbesii*, U.M. Herb. ILLINOIS: Kankakee, *C. C. Crampton* 79, May 12, 1913, U.S.N.M. Herb. 750564; no locality given, *F. Brendel*, no month given, 1873, two plants on this sheet, the one marked 1, U.S.N.M. Herb. 44119.

Should this form prove to be a good variety, and the name *Micranthes* be accepted as the generic name of these Saxifrages, I offer MICRANTHES PENNSYLVANICA HIRSUTA n. var., for this form.

10F. SAXIFRAGA PENNSYLVANICA TOMENTOSA n. var.

Stems stout, 6 to 9 dm. tall, more or less short-pilose, leaves oblong, obtuse, minutely serrulate all around or entire, 6 to 20 cm. long, densely tomentose, especially near the base on the upper surfaces; upper part of the stem glandular-pilose; inflorescence narrow, densely glandular-pilose, the peduncles short, stout, mostly congested. Otherwise like in typical *pennsylvanica*.

Very different looking from *S. pennsylvanica*, as found in New England, but may be only a variation of that species.

Should it prove to be worthy of a name, and the name MICRANTHES is accepted for these Saxifrages, I offer MICRANTHES PENNSYLVANICA TOMENTOSA n. var., as the name of this form.

SPECIMENS EXAMINED: MINNESOTA: Minneapolis, *J. H. Sandberg*, May, 1894, U.M. Herb., TYPE; Goodhue County, *J. H. Sandbarg*, June, 1886, U.M. Herb.; Hennepin County, *J. H. Sandberg*, May, 1880, U.M. Herb.; Minneapolis, *J. C. Hassube*, May 1878, U.M. Herb.; Minneapolis, *Aiton*, May, 1878, U.M. Herb., marked forma *fultior* by Johnson; MacCubbin's Lake, *E. P. Sheldon*, May, 1895, U.M. Herb., marked forma *fultior* by Johnson; no locality, collector and date given, N.M. Herb.; Hennepin County, *F. H. Burglehaus*, May 12, 1891, U.M. Herb.; Rochester, *G. G. Ainslie*, 1831, date not given, U.M. Herb.; Snelling Reservation, *C. O. Rosendahl* 2100, June 15, 1909, two collections on this sheet, one of which I have distinguished above as a variety of *Pennsylvanica*, U.M. Herb. MICHIGAN: Jackson County, *S. H. Camp* and *Dr. R. Camp*, May 30, 1895, U.M. Herb.; Ann Arbor, *J. H. Ehler* 1471, May 17, 1921, U.I. Herb. IOWA: Fayette, *B. Fink*, May, 1893, I. S.C. Herb. ILLINOIS: Wady Petra, *V. H. Chase* 1344, May 19, 1907, U. I. Herb. INDIANA: Elkhart, *C. C. Deam* 33735, May 6, 1921, D. Herb.; Griffith, *C. C. Deam* 40520, June 5, 1924, D. Herb.; Rockford County, *C. C. Deam*, May 7, 1905, D. Herb.; Garrett, *C. C. Deam* 3013, May 17, 1908, D. Herb.; Mount Tom, *R. Kienbolz*, May 8, 1915, U.I. Herb.; Mineral Springs, *C. C. Deam* 12976, May 25, 1913, D. Herb.; Walkerton, *C. C. Deam* 33713, May 5, 1921, D. Herb. VIRGINIA: Williamsburg ,*E. J. Grimes* 3353, March 28, 1921, U.M. Herb.

10G. SAXIFRAGA PENNSYLVANICA DICHOTOMA n. var.

Stems 6 to 10 dm. tall; branches of the inflorescence slender, ascending or upcurced, sometimes springing from the base of the scapes; leaves long-oval, 1.5 to 3 dm. long, 5 to 8 cm. wide, mostly pubescent on both sides, or nearly glabrous, mostly denticulate or entire; inflorescence diffusely branched,

scarcely at all eymose; otherwise as in typical *pennsylvanica*. A very different looking plant from the ordinary *pennsylvanica*, and very likely only an extreme variation of that species.

SPECIMENS EXAMINED: MINNESOTA: Gwinn's Bluff, *C. O. Rosendahl* and *F. K. Butters* 4265, May 11, 1922, U.M. Herb., TYPE; Lake Johanna, *C. O. Rosendahl* 3808, June 18, 1919, U.M. Herb.; Lake Harriet, *L. R. Moyer* and *S. M. Manning*, June 20, 1895, U.M. Herb. INDIANA: Pokogon State Park, *C. C. Deam* 44304, May 26, 1927, D. Herb.; Kendallville, *C. C. Deam* 3089, May 31, 1908, D. Herb.; Ridgeville, *C. C. Deam* 19718, May 16, 1916, D. Herb.; Fremont, *C. C. Deam* 40494, June 4, 1924, D. Herb.

Should this form prove to be a good variety, and the name MICRANTHES be accepted for these Saxifrages, I offer for this form the name MICRANTHES PENNSYLVANICA DICHOTOMA n. var.

10H. SAXIFRAGA PENNSYLVANICA FORBESSI (Vasey) n. var.

S. Forbesii Vasey, Am. Entom. & Bot. *2*: 288. 1870.

Micranthes Forbesii (Vasey) Bush, Mo. Bot. Gard. Rept. *20*: 138. 1909.

Illinois and Missouri, Robinson and Fernald in Manual, l. c. 446.

Illinois and Missouri, Johnson in Revision, l. c. 44.

Saint Louis, Letterman in Tracy's Flora, l. c.

Illinois, Missouri and Iowa, Bush, l. c. 139.

Before Vasey described *S. Forbesii*, and prior to about 1880, all the collectors around Saint Louis, Eggert, Letterman, Engelmann, Trelease and others, called the tall Saxifrage of the Saint Louis region, *S. pennsylvanica*, and this is the name it appeared under in the Manuals and Floras. But after 1880 it was ascertained that *S. Forbesii* occured in that region, and so Eggert, Letterman and the later collectors began naming their collections of the tall plant *Forbesii*, and sending out specimens under this name. In this way it began to make confusion, and the Manuals and Floras either threw the Missouri plant called *Forbesii* into *S. pennsylvanica*, or else disregarded it entirely, and went back to the name *pennsylvanica*

for all of *S. Forbesii*, or at least the Missouri plants.

I have seen good specimens of these two forms collected by Eggert both labeled *S. Forbesii*, same label, same locality, same date and same habitat, thus showing that Eggert did not distinguish the two forms.

SPECIMENS EXAMINED: MISSOURI: Saint Louis, *H. Eggert*, May 1887, U.M. Herb.; Saint Louis, *H. Eggert*, May 11, 1887, U. M. Herb.; Jefferson County, *H. Eggert*, May 11, 1887, evidently the same collection, as the two preceding, which shows that Eggert did not collect this form in Saint Louis County, I.S.C. Herb.; Pacific, *H. Eggert*, May 8, 1886, I.S.C. Herb.; across the Meramec River, in Jefferson County, *H. Eggert*, May 8, 1886, I.S.C. Herb.; Jefferson County, *H. Eggert*, May 8, 1886, U.S.N.M. Herb. 958397; Pacific, Franklin County, *H. Eggert*, May 8, 1886, U.S.N.M. Herb. 754901; Allenton, *G. W. Letterman*, April 16, 1880, U.S.N.M. Herb. 986370; Saint Louis County, *G. W. Letterman*, April, 1880, U.S.N.M. Herb. 44170; Jefferson County, *G. W. Letterman*, April, 1880, U.S. N.M. Herb. 44112; Jefferson County, *G. W. Letterman*, month not given, 1880, U.S.N.M. Herb. 44111; Allenton, *G .W. Letterman*, month not given, 1882, U.S.N.M. Herb. 44113; Allenton, *G. W. Letterman*, April 16, 1880, two sheets, but evidently from across the river in Jefferson County, as is the next cited, I.S.C. Herb.; Allenton, *G. W. Letterman*, June 20, 1887, two plants on one sheet, evidently of two different collections, U.I. Herb. ILLINOIS: Oregon, *M. B. Waite*, June 17, 1885, U.S.N. M. Herb. 491007, two plants on this sheet, the one marked 1; Jackson County, *G. H. French*, May 9, 1873, U.S.N.M. Herb. 772168, three plants on this sheet, the ones marked 2; South Illinois, *G. H. French*, date not given, U.S.N.M. Herb. 44117; Jackson County, *G. H. French*, May 9, 1873, U.S.N.M Herb. 44114; South Illinois, *G. H. French*, month not given, 1875, U.S.N.M. Herb. 44115 and 44116; Oregon, *E. J. Hill*, July 11, 1905, U.I. Herb.

If this form is to be kept up, and the name MICRANTHES is accepted for these Saxifrages, I offer MICRANTHES PENNSYLVANICA FORBESII (Vasey) n. var. for this form.

LITERATURE CITED

1. Britton, Man. of the north. States and Can. 1909.
2. Britton & Brown, Ill. Flora, 1913.
3. Bush, Mo. Bot. Gard. Rept. 1909.
4. Eggert, Cat. Pl. of St. Louis, 1891.
5. Haworth, Syn. Pl. Succ, 1812.
6. Haworth, Saxifr. 1821.
7. Johnson, Rev. N. Am. Sp. *Saxifraga*, 1923.
8. Robinson and Fernold, Gray's New Man., 1908.
9. Small, N. Am. Flora, 1905.
10. Small, Flora S.E.U.S., 1903.
11. Tracy, Cat. Plants of Missouri, 1886.

OBSERVATIONS ON ORGANISMS AND SEDIMENTATION ON SHALLOW SEA-BOTTOMS

RUD. RICHTER

(Reviewed by Walter H. Bucher)

I.—INTRODUCTION

In the publications of the Senckenberg Museum at Frankfort a. M., Dr. Rud. Richter has published a series of observations on organisms and sedimentary processes on shallow seabottoms which he made in the North Sea off the coast of Schleswig-Holstein. His critical treatment of his observations based on a comprehensive knowledge of the literature (which is quoted extensively) makes these papers unusually valuable to the student of palaeo-ecology and of sedimentation. This is the first of several abstracts written in order to make this material more accessible to American students. A wealth of references and of critical detail had to remain untouched in these abstracts. For it the reader is referred to the original.

II.—*Scolithus* Hald. versus *Sabellaria alveolata* L.

1—Richter, Rud.—Ein devonischer Pfeifenquartzit, Senckenbergiana, Vol 2, 1920, Heft 6, pp. 215-235.

2—Richter, Rud.—Scolithus, Sabellarifex and Geflechtquarzite, ibid., Vol. 3, 1921, pp. 49-52.

3—Richter, Rud.—Sandkorallen-Riffe in der Nordsee, Natur und Museum, 57. Bericht der Senckenbergischen Gesellschaft, Frankfurt a. M., 1927, Heft 2, pp. 49-62.

4—Galeine, C. et C. Houlbert—Les récifes d'Hermelles et l'assèchement de la baie du Mont-Saint-Michel. Bull. Soc. géol. et min. de Bretagne, 2, (1921) 1922, pp. 319-324; (quoted in 3.)

In the fall of 1919, Dr. Richter observed, ten miles east of Büsum on the west coast of Holstein, large flat-topped reefs which, at low tide, stood as much as 30 cm. above the water surface (fig. 1-3, p. 222 of 1). They were found to consist entirely of closely packed tubes of the annelid *Sabellaria alveolata* L. Each individual of this worm is encased in a tubular sheath about 2 mm. in diameter, built of a mosaic of sandgrains cemented by a slimy secretion. Each tube is built up vertically from the surface of the sand by the animal, which occupies the tube head-up and reaches out with its tentacles for planctonic food. The tubes are so closely packed that only the width of a few sandgrains intervenes between adjacent ones, giving the surface of the reef the appearance of a huge, small-celled honey-comb, or of a coral colony such as Tubipora. Locally it is known as "sand coral." The whole mass, including the small amount of sand-matrix, is sufficiently cemented so that rolled fragments occur as pebbles, e. g. on the shore of the East Friesian island, Langeoog. Blocks weighing many pounds were shipped to the museum without difficulty.

The ecological aspect of these worm communities is striking. They are limited to pure sand bottoms practically free from mud. They lack practically all other larger forms of life. Only rarely a single valve of a pelecypod was seen caught between the tubes. The individual tubes are slightly wavy but never deviate much from a straight line. The organic cement is inconspicuous. It is obvious that after its destruction, in the fossil state it would be impossible to tell the sand grains that form the tube from the matrix which is more or less permeated by the same cementing secretion.

It is interesting that a closely related species, *S. spinulosa* Leuck, forms loosely intertwined tubes like the sand coral. It grows into solid colonies which encroach on oyster banks, completely overgrowing and destroying them.

This latter form seems to be well known to zoologists, while the straight-tubed form appears largely to have been overlooked even in zoological circles. With one obscure excep-

tion quoted by Dr. Richter, it seems to have escaped notice by geologists. Yet its existence solves the puzzle of the curious "pipe-rock" of the Cambrian of Fennoscandia and the Canadian shield and related early Paleozoic forms to which the name *Scolithus* was given in 1840 by Haldeman, and about which a voluminous, largely speculative literature has grown up.

The essential characteristics of *Scolithus* (e. g. *S. linearis* Hall of the Potsdam s. s.) may be listed as follows:

1.—More or less straight; often almost mathematically straight; simple tubes that never communicate or branch.
2.—Diam. from less than 3 mm. to over 12 mm.; length from a few cm. to over 1 meter.
3.—Interior of the walls often delicately annulated.
4.—Cutting across the strata parallel to each other and always normal to the bedding planes.
5.—In places so closely crowded that but few sand grains intervene between adjacent tubes.
6.—Limited to nearly pure sandstones.
7.—The sand between the tubes often distinctly and minutely bedded; the lines of bedding not disturbed where the tubes cut across them.
8.—Generally in beds devoid of other fossils.
9.—Widespread at definite stratigraphic horizons, (used successfully, for instance, by Peach in subdividing the Lower Cambrian of Scotland.)
10.—Limited to the Lower Paleozoic.

Points 9 and 10 speak forcibly against any suggested mechanical origin of these tubes, such as rising air or gas bubbles. The extreme case of crowding (5) also seems incompatible with a mechanical origin.

1, 5, 7 and 8 prove that these Scolithus tubes can not have been produced as tunnels by mud-eating worms burrowing in the sand.

No. 6 excludes the stems of algae as possible cause of these tubes, since algae do not grow on bottoms covered with drift-

ing, pure sand. For the existence of higher plants all proof is lacking.

All possible modes of origin suggested so far have failed. Each of the characteristics enumerated above, on the other hand, agrees with the observed habits of *Sabellaria alveolata*, such as the unbranched character of the tubes (1); the annulation of the inner walls which correspond to growth lines (3); the position of these tubes in the strata and their crowding (4 and 5); their restriction to pure quartz sand (6); the undisturbed lamination of the sand between them (7); the absence of other life (8), and the widespread distribution at definite stratigraphic horizons (9), and finally, the restriction to a limited division of time (10).

Fossil tubes distinctly referable to this type have been described from the Cambrian of Fennoscandia and Northeastern North America and from the Lower Silurian of New York. To these Dr. Richter adds a species from the Lower Devonian of the Eifel (2, pp. 215-217). No later record of similar tubes seems to exist. This may be due to a change in the nature of the slimy secretion of *Sabellaria*-like worms, which rendered the preservation of these tubes more difficult or impossible since the later Paleozoic,—or the habit of molding such straight tubes of sand mosaic may have arisen independently in different groups of annelids or even entirely different worm-like organisms. It seems wise, therefore, to retain the name *Scolithus* for the early Paleozoic tubes.

Dr. Richter proposes to limit the name *Scolithus* to the surprisingly, almost mathematically, straight forms which show a tendency to be closely crowded, especially in the Scandinavian specimens. For the other forms, which show slight undulations and less strictly parallel growth of the vertical tubes and a tendency to be less crowded, he proposes the name *Sabellarifex*.[1]

If field observations at the type localities of *Scolithus* s.

1 *Sabellarites*, the name given in the first paper, had to be dropped because preoccupied by Dawson in 1890.

str. should show transitions between these types, the tentative name *Sabellarifex* would become superfluous.

It is obvious that most of the names attached to the various products of the activity of annelids in the geological past have little or no taxonomic significance. They do, however, represent distinct ecological types. As such these remains deserve careful attention. The formal relation between the various groups is brought out in the following tabulation quoted from Dr. Richter (1, p. 226) (with a few changes):

Types of Annelid remains:

A. Tubular sheaths built by tubicolous annelids.

1. Sheaths consist of a mosaic of sand grains cemented by an organic secretion.
   Sabellaria L. (?) (Secretion limited to sandy bottoms; chooses sand grains only, even when shell fragments abound (2, p. 50).
   Sabellarifex Richter.
   Scolithus Haldeman s. str.

2. Sheaths consist of a membraneous substance reinforced with agglutinated foreign bodies (fragments of shells, sand grains, etc.)
   Terebella Cuvier
   Terebellina Ulrich.
   Sabellarites Dawson (defined as "composed of sand and calcareous organic fragments, associated with carbonaceous flocculent matter, indicating a horny or membranous sheath—Q.J.G.S. Vol. 46, 1890, p. 605-6.)

3. Sheaths consist of calcium carbonate.
   Serpula L.
   Spirorbis Dandin.

B. Holes and burrows in the sediment made by Tubicola or by Errantia.

1. Tubular holes normal to bedding plane; cavities that held the cylindrical bodies of tubicolous annelids.

   Arenicola Linnaeus *Monocraterion* Torell
   Arenicolites Salter *Diplocraterion* Torell
   Histioderma Kinehan

2. Irregular tubular cavities cut into sediment in any direction—burrows of mud-eating annelids.
   Planolites Nicholson

3. Cavities in hard parts of other animals produced by parasitic Errantia:
   Myzostoma Leuckart

C. Tracks on surface of sediment:
   Crossopodia McCoy *Myrianites* McLeay
   Nemertites McLeay

The ecologic aspects of the "sand corals" is further developed in the delightful, well-illustrated account in "Natur und Museum" (3). The straight organ-pipe form of tubes appears limited to the reefs whose surface lies close to the water surface, to the ceaseless action of breaking waves. It is clearly a response to specific mechanical conditions. If true, this is valuable information to the paleogeographer.

Reefs of *Sabellaria* form a barrier 3 km. wide and 10 km. long across the famous bay of Mont-Saint-Michel in the Bretagne, having grown 6 m. high, hastening the silting up of the bay. (4, quoted in 3). It is surprising that such aggressive reef-growth should have escaped wider notice. It is even stranger that apparently none of the experienced captains of ships in the service of the coast control in German waters have ever seen before 1919 such reefs as now exist, although *Sabellaria* has long been a familiar member of the North Sea fauna. It looks as if a widspread expansion of the reef-forming tendencies of *Sabellaria* had taken place within the last decade in North Sea waters. It is just such sudden expansions that have given us in the geologic past widely spread strata

of limited vertical extent such as the *Scolithus* beds in the lower Cambrian of Scotland.

Finally, these sand reefs offer wonderful illustrations of victory and defeat in the struggle of colonies of marine organisms. Oyster banks are strangled and overgrown by *Sabellaria*. *Sabellaria* reefs, in turn, are suffocated by the dense web of byssus threads spun by the myriads of Mytilus brood. Almost solid layers of byssus-bearing pelecypods overlying nearly pure sand piped with closely crowded *Scolithus*-like tubes,—what an unreasonable sequence of sedimentation we geologists would call this had we found it somewhere in the Paleozoic! Yet here Dr. Richter shows us photographs of just such reefs and their materials, some taken while the megaphone of the boat that could not reach him warned him of the returning tide.

A LIST OF PLANTS FROM THE MISSOURI OZARKS

H. W. RICKETT

The list which follows is based upon collections and observations made in the Ozarks of Missouri during August, 1927. The vegetation of this region is scantily represented in the Herbarium of the University of Missouri and imperfectly known at least to the botanists of that institution. An exploratory trip was therefore made in a truck belonging to the Department of Botany through certain parts of Southern Missouri. The route followed is indicated in the accompanying map. It was planned only with the aim of seeing as much of the country as possible in so limited a time without undue haste. The party camped along the way, and spent usually several days in each spot of interest. Most of the country covered supports a forest of oak, with a scattering of other trees, notably pine and hickory. In the valleys are cleared regions. Here and there arise the great springs, flowing perhaps several millions of gallons a day, creating moist places where various ferns flourish. In a few places, as noted below, swamps occur, with characteristic vegetation.

In addition to the species named in the list, casual notice was taken of others inhabiting the springs. These were not, for lack of proper equipment, collected and identified. The following were recognized: *Myriophyllum sp.*, in Meramec Springs, Phelps County: *Potamogeton sp.* (probably *P. pectinatus* L.) and *Naias sp.* in the spring at Yancy Mill, Phelps County; *Vallisneria spiralis L.*, in the spring at Howe's Mill; and *Radicula Nasturtium-aquaticum* (L.) Britten and Rendle, growing several feet in height from the bottom of the spring at Centerville, Reynolds County, also at Yancy Mill.

ited time forbad the inclusion of all groups. Neither are Bryophytes included in the list, since these were

not studied carefully. Passing mention can be made of the abundance of mosses at the Shut-In of the Black River,

notably Climacium, Thuidium, Dicranum, Catharinea, Entodon. Polytrichum, which is apparently rare in Misscuri, was found on the granite boulders near Graniteville. Of the liverworts, Porella and Conocephalum were found near the water at Big Spring State Park, Van Buren; and Marchantia by Meramec Spring.

A noteworthy feature of the vegetation is the prominence of Leguminosae. This family was represented by thirty-two species in ten genera, and was abundant everywhere, especially the various species of Desmodium and Lespedeza. The characteristic habitat of the family is the dry, oak-covered hillsides.

The Leguminosae were exceeded in number of species only by the Compositae; these, however, had not yet attained their greatest abundance. Most of the Asters and Golden Rods had not yet come into bloom.

Certain members of the Labiatae were very abundant. The straggling stems of Dittany (Cunila) contended with Desmodium for the ground under the oaks on the hills; and the odorous Pennyroyal (Hedeoma) covered the openings and disused roads.

The ferns were well represented only near the springs and on the rocks of the Shut-In of the East Fork.

A detailed list follows of the stations at which collections and observations were made, in the order in which they were visited.

1. Marie's Creek, Westphalia, Osage County.
2. Highway 63, detour between Vienna and St. James, Marie's County.
3. Meramec Spring and neighborhood, Phelps County.
4. Little Piney Creek on Highway 63, Phelps County; a sandy and stony creek bottom well covered by sycamore.
5. Yancy Mills, a quarter mile from the preceding; road through woods, a spring, a swamp, and cornfields.
6. Highway 32 between Licking and Salem, Dent County.
7. Camp ground at Salem, Dent County; a vacant lot at the edge of the town.
8. Howe's Mill, Dent County; including a small swamp near the spring.
9. Granite boulders near Graniteville, Iron County.

10. Highway 21 between Glover and Lesterville, Iron County.
11. On the East Fork of the Black River, near Lesterville, Reynolds County; including a curious mixture of sand, bearing Opuntia, with swamp.
12. Bluff above East Fork near Lesterville.
13. Big Shut-In of the East Fork and neighborhood; an interesting formation caused by the prominence of old granite and basalt rocks through the softer limestone.
14. Shut-In Creek; a tributary of the East Fork some five miles from the Big Shut-In, which has cut down to the same rocks.
15. Big Spring State Park, near Van Buren, Carter County.
16. Highway 60 near Birch Tree, Shannon County; in the midst of a high, flat, and dry country which occupies the central Southern portion of the State.
17. On the Piney Fork near Cabool, Texas County.
18. Near Smittle Cave, Wright County.
19. Bennett Spring State Park, Laclede County.

LIST OF PLANTS

The numbers in parentheses which follow the names refer to the places of collection; each number refers to the station so numbered in the list above.

For convenience in reference, the terminology accords with that in Gray's New Manual of Botany, 1908.

POLYPODIACEAE

Adiantum pedatum L. (13, 15)
Aspidium marginale (L.) Sw. (9, 13, 15)
Asplenium angustifolium Michx. (15)
A. platyneuron (L.) Oakes. (13, 15)
A. Trichomanes L. (13)

TWENTY-FIVE

Camptosorus rhizophyllus (L.) Link. (15)
Cheilanthes Feei Moore. (13)
Cystopteris bulbifera (L.) Bernh. (13, 15)
Pellaea atropurpurea (L.) Link. (13, 15)
Phegopteris Dryopteris (L.) Fee. (13)
P. hexagonoptera (Michx.) Fee. (13)
Polypodium polypodioides (L.) Hitchc. (13)—growing on rock overhanging smaller spring.
Polystichum acrostichoides (Michx.) Schott. (13, 15)
Woodsia obtusa (Spreng.) Torr. (13)

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. (13)

ALISMACEAE

Lophotocarpus calycinus (Engelm.) J. G. Sm. (8)

COMMELINACEAE

Commelina virginica L. (4, 15)

LILIACEAE

Allium cernuum Roth. (5)

IRIDACEAE

Belamcanda chinensis (L.) DC. (5)

ORCHIDACEAE

Hexalectris aphylla (Nutt.) Raf. (4)—one plant, high on bluff.

URTICACEAE

Pilea pumila (L.) Gray. (7)

POLYGONACEAE

Polygonum Hydropiper L. (4, 11, 13, 18)
P. lapathifolium L. (4)
P. Persicaria L. (5)
P. scandens L. (5, 13, 15)
P. virginianum L. (11, 13, 15)

PHYTOLACCACEAE

Phytolacca decandra L. (5, 13)

AIZOACEAE

Mollugo verticillata L. (4)

CARYOPHYLLACEAE

Dianthus Armeria L. (4)
Saponaria officinalis L. (4, 11, 13)

RANUNCULACEAE

Aquilegia canadensis L. (15)
Cimicifuga racemosa (L.) Nutt. (13)
Hepatica acutiloba DC. (12)

CAPPARIDACEAE

Polanisia trachysperma T. & G. (11)

CRASSULACEAE

Penthorum sedoides L. (8)

SAXIFRAGACEAE

Heuchera sp. (H. americana L. ?) (13, 15)

ROSACEAE

Agrimonia mollis (T. & G.) Britton. (2, 13, 16)
A. striata Michx. (12)
Geum canadense Jacq. (5, 15)
Gillenia stipulata (Muhl.) Trel. (12)
Potentilla canadensis L. (13)
P. monspeliensis L. (5)
Rosa humilis Marsh. (13)
Rubus villosus Ait. (13)

LEGUMINOSAE

Amorpha canescens Pursh. (13)
Amphicarpa Pitcheri T. & G. (5, 10, 12, 13, 16)
Cassia Chamaecrista L. (5, 13, etc.)
C. Medsgeri Shafer (11)
C. nictitans L. (2, 5, 8, 11, 18)
Desmodium bracteosum (Michx.) DC. (8)
D. canescens (L.) DC. (5)
D. Dillenii Darl. (5, 12)
D. grandiflorum (Walt.) DC. (8, 12, 18)
D. laevigatum (Nutt.) DC. (12)
D. marilandicum (L.) DC. (13)
D. nudiflorum (L.) DC. (8)
D. obtusum (Muhl.) DC. (12, 16)
D. paniculatum (L) DC. (17)
D. paniculatum pubens T. & G. (5)
D. rigidum (Ell.) DC. (16)
D. rotundifolium (Michx.) DC. (12, 18)

D. sessiliflorum (Torr.) T. & G. (3)
D. viridiflorum (L.) Beck. (18)
Lespedeza frutescens (L.) Britton. (12)
L. hirta (L.) Hornem. (9, 12, 18)
L. procumbens Michx. (10, 16)
L. repens (L.) Bart. (8, 10, 13, 18)
L. striata (Thumb.) H. & A. (8, 13, 18)—common by roadsides.
L. Stuvei Nutt. (4)
L. virginica (L.) Britton. (12, 13, 16)
Schrankia uncinata Willd. (16)
Strophostyles helvola (L.) Britton. (4, 12)
S. pauciflora (Benth.) Wats. (2)
Stylosanthes biflora hispidissima (Michx.) Pollard and Ball. (2, 12)—typically with *Lespedeza striata*
Tephrosia virginiana (L.) Pers. (16)

LINACEAE

Linum medium (Planch.) Britton. (13, 18)

OXALIDACEAE

Oxalis corniculata L. (5, 11)
O. repens Thunb. (11)
O. stricta L. (8, 13)
O. violacea L. (13)

POLYGALACEAE

Polygala sanguinea L. (4)
P. Senega L. (11)
P. Senega tenuifolia Pursh. (6)

EUPHORBIACEAE

Acalypha gracilens Gray. (13)
Croton capitatus Michx. (11)
C. glandulosus septentrionalis Muell. Arg. (5)
C. monanthogynus Michx. (4, 9, 11, 13)
Euphorbia corollata L. (3, 13, 16, 18)
E. heterophylla L. (4, 13)
E. Preslii Guss. (4, 11)

BALSAMINACEAE

Impatiens biflora Walt. (5, 18)

MALVACEAE

Abutilon Theophrasti Medic. (5)
Sida spinosa L. (1, 11)

HYPERICACEAE

Ascyrum hypericoides L. (12, 13)
Hypericum cistifolium Lam. (12)
H. gentianoides (L.) BSP. (9)
H. prolificum L. (13)
H. punctatum Lam. (5, 13)

VIOLACEAE

Hybanthus concolor (Forster) Spreng. (12)
Viola pedata L. (9)—in flower

CACTACEAE

Opuntia Rafinesquii Engelm. (11, 13)

LYTHRACEAE

Cuphea petiolata (L.) Koehne. (3, 5, 11, 13, 18)
Lythrum alatum Pursh. (4)

ONAGRACEAE

Epilobium coloratum Muhl. (8)
Gaura biennis L. (4, 11, 13, 15)
Ludvigia alternifolia L. (14)
Oenothera biennis L. (4, 5, 13, 15)—common throughout
O. laciniata Hill. (11)

UMBELLIFERAE

Daucus Carota L. (13)
Sanicula sp. (12, 13)
Thaspium sp. (12)
Zizia sp. (12)

PRIMULACEAE

Steironema quadriflorum (Sims) Hitchc. (8)

ASCLEPIADACEAE

Asclepias incarnata L. (8)
A. purpurascens L. (11)
A. verticillata L. (13)

CONVOLVULACEAE

Convolvulus sepium L. (13)
Cuscuta sp. (5)
Ipomoea hederacea Jacq. (5, 11, 13)
I. pandurata (L.) G. F. W. Mey. (3)
I. purpurea (L.) Roth. (5)

POLEMONIACEAE

Phlox pilosa L. (12, 13)

BORAGINACEAE

Echium vulgare L. (11)
Heliotropium tenellum (Nutt.) Torr. (12)
Lappula virginiana L. (11, 13)

VERBENACEAE

Lippia lanceolata Michx. (8)
Verbena angustifolia Michx. (5, 11, 13)
V. canadensis (L.) Britton. (11. 13)
V. strica Vent. (4, 11, 13)
V. urticaefolia L. (4, 11, 13)

LABITAE

Blephilia sp. (12)
Collinsonia canadensis L. (12)
Cunila origanoides (L.) Britton (8, 12, 13, 16, 18)—common in oak woods.
Hedeoma pulegioides (L.) Pers. (8, 11, 13)—common throughout.
Isanthus brachiatus (L.) BSP. (11)
Lycopus americanus Muhl. (11)
Mentha citrata Ehrh. (?) (8)—possibly a large form of *M. piperita*
M. piperita L. (8)
M. spicata L. (5)
Monarda Bradburiana Beck. (8, 13, 18)
M. fistulosa L. (5)
Nepeta Cataria L. (3)
Physostegia virginiana (L.) Benth. (8, 13)
Prunella vulgaris L. (4, 13)
Pycnanthemum flexuosum (Walt.) BSP. (6, 13)
P. pilosum Nutt. (3, 5)
P. virginianum (L.) Durand and Jackson (8)
Satureja glabra (Nutt.) Fernald. (11)
Scutellaria canescens Nutt. (6)
S. lateriflora L. (13)
S. versicolor Nutt. (12, 13)
Stachys tenuifolia Willd. (5, 13)
Teucrium canadense L. (12)
Trichostema dichotomum L. (9, 13)

SOLANACEAE

Datura Stramonium L. (5, 13)
Solanum carolinense L. (5, 11, 13)
S. nigrum L. (13, 18)

SCROPHULARIACEAE

Gerardia grandiflora Benth. (5, 18)
G. pedicularis L. (16)
G. Skinneriana Wood (16)
G. virginica (L.) BSP. (8, 12)—corolla glabrous within except at base.
Mimulus alatus Ait. (3, 8, 11)
Verbascum Blattaria L. (8, 11, 13)
V. Thapsus L. (4, 11, 13)
Scrophularia marilandica L. (5)

ACANTHACEAE

Ruellia pedunculata Torr. (12)
R. strepens L. (8)—in flower.

PHRYMACEAE

Phryma Leptostachya L. (12)

PLANTAGINACEAE

Plantago major L. (5)

RUBIACEAE

Cephalanthus occidentalis L. (11)
Diodia teres Walt. (4, 11, 13)—thick mats on roadsides.
Galium arkansanum Gray. (12)
G. pilosum Ait. (12, 13)
G. triflorum Michx. (15)
Houstonia angustifolia Michx. (4, 11, 13)

CAPRIFOLIACEAE

Symphoricarpos orbiculatus Moench. (5, 12, 13)—fruit.
Triosteum sp. (13)—fruit.
Viburnum alnifolium Marsh. (4)—coarsely-toothed ovate leaves.

CAMPANULACEAE

Campanula americana L. (5, 11, 15, 18)

LOBELIACEAE

Lobelia inflata L. (5, 12, 13)
L. siphilitica L. (8, 18)
L. spicata Lam. (12)

COMPOSITAE

Actinomeris alternifolia (L.) DC. (1, 5, 11, 13, 17)—common along roadsides.
Ambrosia artemisiifolia L. (5, 13)
A. bidentata Michx. (13)
A. trifida L. (5, 17)

Anthemis Cotula L. (5, 11, 13)
Arctium Lappa L. (5)
Aster anomalus Engelm. (12, 13, 18)
A. ericoides L. (5, 13, 15)—very abundant locally.
A. patens Ait. (3, 8, 13, 16)
A. sagittifolius Wedemeyer (17)
Bidens bipinnata L. (5, 11, 13)
Cacalia atriplicifolia L. (11, 13)
Chrysanthemum leucanthemum L. (8, 13)
Cirsium altissimum (L.) Spreng. (8, 11, 13)
C. lanceolatum (L.) Hill. (13)
Coreopsis lanceolata L. (13)
C. palmata Nutt. (2)
C. tripteris L. (13)
Elephantopus carolinianus Willd. (1, 5, 11, 13, 15)—common in woods.
Erigeron ramosus (Walt.) BSP. (5, 13, 15)—in flower.
Eupatorum coelestinum L. (11, 19)
E. perfoliatum L. (5)
E. purpureum L. (11)
E. serotinum Michx. (4, 15)
E. urticaefolium Reichart. (17, 19)
Helenium autumnale L. (4, 8)
H. nudiflorum Nutt. (3, 5, 8)
H. tenuifolium Nutt. (9, 11, 13)—abundant along roadsides and in fields.
Helianthus hirsutus Raf. (13)
Heliopsis scabra Dunal. (10, 12, 13)
Hieracium Gronovii L. (3, 18)
H. longipilum Torr. (9, 12)
H. scabrum Michx. (13)
Krigia amplexicaulis Nutt. (18)—in flower.
Lactuca canadensis L. (16)
Liatris cylindracea Michx. (13)
L. scariosa Willd. (4)
L. squarrosa Willd. (13)
Polymnia canadensis radiata Gray (15, 19)
Pyrrhopappus carolinianus (Walt.) DC. (5)
Rudbeckia fulgida Ait. (12)
R. hirta L. (5)
R. laciniata L. (13, 15)
R. subtomentosa Pursh. (8)
R. triloba L. (5, 8, 12, 13, 17)—common throughout.
Silphium integrifolium Michx. (5, 12)
S. perfoliatum L. (5)

S. terebinthinaceum Jacq. (8, 12)
Solidago hispida Muhl. (13)
S. nemoralis Ait. (13)
S. ulmifolia Muhl. (3, 17)
Verbesina virginica L. (11)
Vernonia altissima Nutt. (15)
V. Baldwini Torr. (5, 8, 11)
V. crinita Raf. (4, 8, 11, 13)
V. illinoensis Gleason (7)
V. interior Small (8)—(included by Gray in *V. Baldwini.*)

NOTES ON THE GENUS HYDRANGEA

T. G. HARBISON

Hydrangea arborescens L. is admissibly a very variable species, but my observation of this species over a wide territory for many years leads me to believe that at least one variety is distinct enough to be worthy of a anme. Extending from Union Springs, Bullock county, Alabama, to Forestville, Wake county, North Carolina, in the upper Piedmont country there is a variety of Hydrangea arborescens L. with deeply cordate, broadly ovate, abruptly acuminate leaves, glabrous on the under side with very short petioles. This variety is represented in the National Herbarium by material from Union Springs, Bullock county, Alabama, Biltmore Herbarium, June 18, 1902; Forestville, Wake county, North Carolina, Biltmore Herbarium, June 14, 1900; Kennesaw Mt., Cobb county, Georgia, Biltmore Herbarium, June 24, 1899; also from Kennesaw Mt. by Percy Wilson, June 12, 1900. The specimen in the National Herbarium bearing the number 1339i, collected by the writer at Union Springs, Alabama, June 18, 1902, is suggested for the type of

HYDRANGEA ARBORESCENS var. AUSTRALIS, n. var.

Differs from the type in its deeply cordate and more broadly ovate leaves which are abruptly acuminate and in its short petioles which are less than half as long as the blades. The leaves of this variety seem to be consistently glabrous whereas in the type leaves more or less pubescent are not uncommon.

Mr. W. W. Ashe has sent me specimens of a species of Hydrangea from Arkansas both in flower and fruit that does not agree with any of the described species of this genus. I take pleasure in associating the name of the discoverer with this species.

HYDRANGEA ASHEI, n. sp. A shrub 4 to 8 dm. tall with clustered stems; winter twigs of the year angled with smooth and tan-colored bark; bark on the older stems exfoliating in thin layers, the inner bark greenish gray. Leaves ovate, broadly ovate, to orbicular-ovate, or rarely oblong-ovate, from 7 to 11 cm. long by 4 to 9 cm. broad, abruptly taper-pointed, rounded, subcordate or cordate at the base, coarsely and sharply serrate with straight teeth nearly to the base; the lower surface permanently pubescent with short simple hairs on the surface of the blade as well as on the veins! petioles flattened and pubescent on the upper surface, rounded and glabrous on the lower.

Inflorescense a compound cyme, 4 to 12 cm. wide and from 3 to 6 cm. high, more or less pubescent, the peduncle eventually nearly glabrous; flowers appearing the last of June to the middle of July or occasionally later are cream-colored, the perfect ones about 2.5 mm. long including the stamens, with fugacious orbicular petals about 1 mm. in diameter, anthers cream-colored; calyx a crown with pointed teeth; the usually few marginal sterile flowers are about 12 mm. wide, the small segments orbicular-ovate to orbicular. Fruit maturing in September or later is prominently about 10-ribbed, barely 2 mm. long including the short persistent spreading styles, and about the same width.

The proposed species seems to be essentially Ozarkian in its distribution, extending according to Mr. Ashe's specimens from Montgomery county, Arkansas to Stone county in the same State. He reports it as being not uncommon along rocky banks of small streams but also as entering moist stony woods as near to summit of the north slope of Boston mountain in Newton county, Arkansas.

The affinities of this proposed species, in its broadly ovate and cordate leaves, in its pubescence and in its small marginal sterile flowers seem to be with Hydrangea cinera Small rather than with Hydrangea arborescens L. which it superficially resembles. H. arborescens rarely has cordate leaves whereas at least the lower leaves of this plant are prevailingly

cordate. The lower surface of the leaves of H. arborescens are essentially glabrous except on the veins, but the leaves of his species on their entire lower surface are invariably pubescent. The sterile flowers of H. arborescent as a rule are about twice the size of those of the proposed species, and both fertile flowers and capsules of H. arborescens seem to be consistently larger. In comparison with H. cinerea its pubrescense is much less copious, never sufficient to whiten the lower surface of the leaf.

Mr. Ashe reports having had this species in cultivation in Washington, D. C., since 1926, it having bloomed and fruited freely two seasons. These plants came from Montgomery Creek, Montgomery county, Arkansas, along the stony banks of which it is common in deep hollows. Fresh material from these cultivated plants was furnished me for study and comparison with that of H. cinerea and H. arborescens, both of which are found on the Highlands Plateau. The type material upon which I have based my description of this proposed species is from Montgomery Creek, Montgomery County, Arkansas.

T. G. HARBISON

Highlands, N. C.

A SIMPLE TRAP FOR THE CAPTURE OF TERRESTRIAL ISOPODS*

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Students of the terrestrial isopods know how difficult it is to collect in quantities certain small and active species of these animals, or the young of the larger species. In the past, the writer, for example, when collecting such small forms could proceed only by scooping up with a trowel into an earthen pot quantities of soil, leaf-mould, etc., containing such forms in large numbers. The pot was then taken to the laboratory; the material, in small amounts, laid out upon a glass plate or a piece of glazed paper, and the individuals picked out slowly as search among the material revealed them. In this way limited amounts of the desired material were secured. However, with the most expert collecting many, in fact, *most* of the more active individuals escape of such species as *Metoponorthus pruinosus, Porcellio laevis*, etc. The below method, devised by the writer in connection with certain problems regarding distribution, sex-ratio, color-variation, sexual periodicity, and migration of the Isopods, during the past three years, has given most excellent results. In the course of this work I employed a simple but most effective trap made of a potato or carrot. The trap also frequently yields myriapods, arachnids, and occasionally small beetles, and the method seems well worth publishing.

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* The writer quite unconsciously followed in this device a method which, according to GRAEVE (*Inaugural-Dissertation, Bonn*, 1913) has been for some time used by German mushroom-growers for the capture of *Porcellio laevis!* Mature reflection suggests the desirability of publication of the method, which is deserving of a better acquaintance among students of the Isopoda.

An ordinary potato is bored completely through lengthwise with a large cork-borer in the manner of preparing potato-plugs for bacteriological use. Long, thin potatoes make the best traps, and only one plug of potato is removed. A short section of the plug removed is cut off to serve as a stopper at one end of the potato, the other end being left open. After preparation, the traps should be laid in piles of litter where sowbugs are known to be abundant and lightly covered with litter. They may be baited at first with bacon (although this is not often necessary).

After the trap has been in place for some time it is uncovered and held horizontally while the litter is removed from the surface of the potato. The trap is then held vertically, sharply tapped, and the contents of the trap shaken into a dry, white porcelain evaporating dish. The material is then cleaned, dropped (if desired) into 80% alcohol, and then picked over at will.

With these traps the writer has obtained in abundance species that by ordinary methods of collection are "rare" for this locality. For instance, *Philoscia muscorum*, which appears very rarely in my older records now appears frequently in my collections. All sorts of rare juvenile stages also are obtained, and in a clean, bright condition. A small trap will sometimes yield on a good haul 60 individuals, while a large, much-eaten trap may contain as many as 300 adults of *Armadillidium or Porcellio laevis*. Small traps may have as many as 150 young *Metoponorthus* or *Porcellio laevis* or *Armadillidium vulgare*. Swift-moving species are collected with the loss of very few individuals by the use of the potato-trap. The writer suggests that this method be used with the smaller species which are collected with difficulty in the old way.

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